FORT KEOGH

LIVESTOCK AND RANGE RESEARCH STATION

MILES CITY, MONTANA

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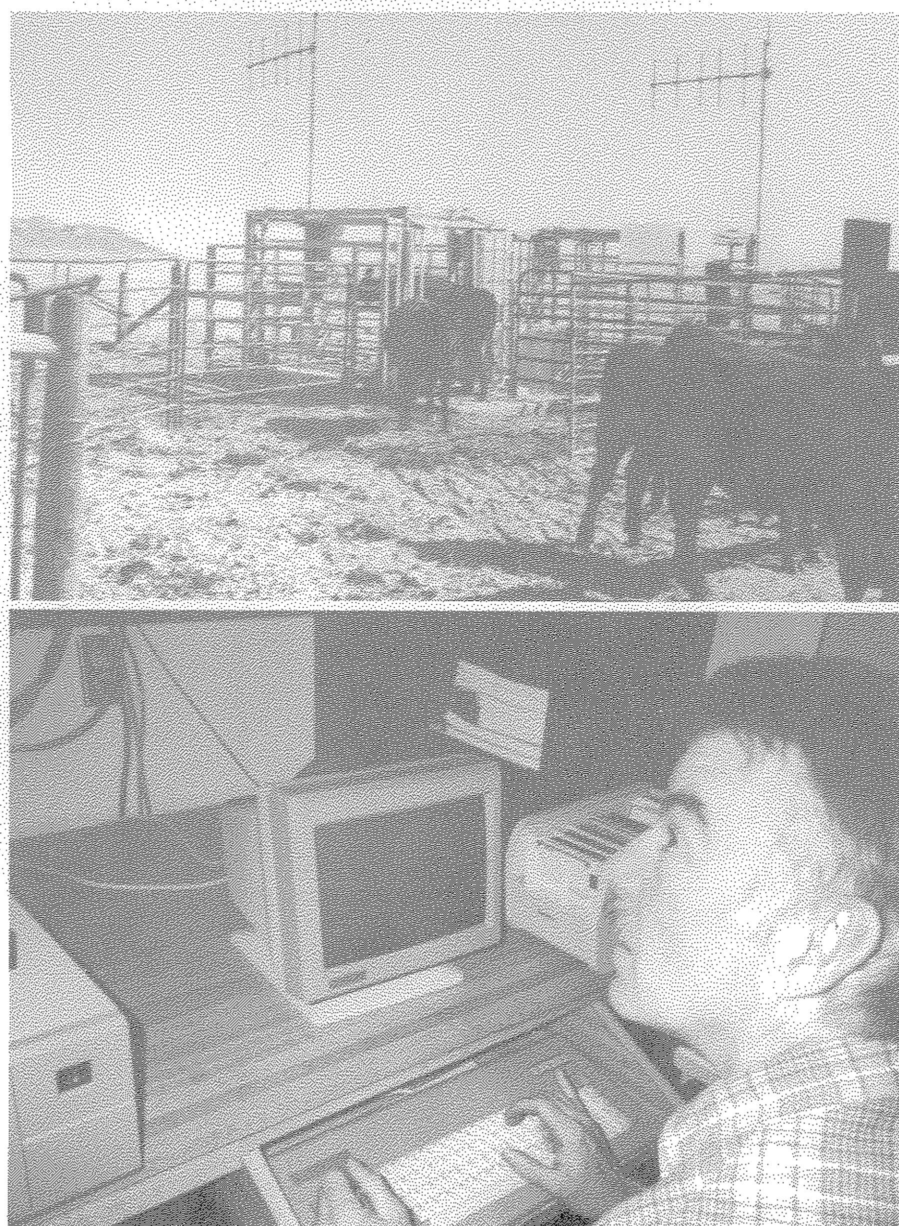
1987 FIELD DAY

RESEARCH IN ACTION



RESEARCH IN ACTION

AGRICULTURAL RESEARCH SERVICE
UNITED STATES DEPARTMENT OF AGRICULTURE
IN COOPERATION WITH
MONTANA AGRICULTURAL EXPERIMENT STATION

SX SEPTEMBER 14, 1987 SX

1987

PRODUCER RECOGNITION AWARD

J. L. (Jack) Cooper
Willow Creek, Montana

L. J. (Les) Holden
Valier, Montana

Presentation of the 1987 Producer Recognition Award to Jack Cooper and Les Holden is in recognition of their lifetime accomplishments in breeding purebred Hereford cattle. Support of the livestock industry is an essential ingredient to the success of research programs such as those here at the Fort Keogh Livestock and Range Research Station. We want to say, **"Thank You"** and take the opportunity to recognize these two ranchers who are half-brothers and have separate livestock operations running about 130 mother cows each.

BIOGRAPHIES

J. L. (Jack) Cooper and L. J. (Les) Holden

Les Holden and Jack Cooper both started out in the commercial Hereford business in the era when Herefords were the predominant breed. From the 1940's to the early 1950's, they added purebreds and proceeded to convert their commercial herds to purebreds. The histories of Cooper-Holden Herefords are classic examples of taking new beef cattle breeding findings from research laboratories to the ranch to improve the genetic merit of beef cattle for growth and maternal performance. They have also used the latest research in pasture and forage production management to support the genetic potential of their improved Line 1 cattle.

In the initial stages of herd improvement, they obtained Line 1, progeny-tested sires and some of the older mother cows from the U. S. Range Livestock Experiment Station, Miles City. Initially, they also used a few purebred seedstock from other breeders to establish a wide genetic base. They initiated rigid selection procedures within their own herds to determine superiority of replacements to be retained. As early as 1956, interest in the recordkeeping systems for improving production in their herds was evidenced by the leadership both men played as members in the Montana Beef Improvement Association. The philosophy of Les Holden and Jack Cooper is "the commercial man has always been our bread and butter." In recent years, they have sold cattle to other purebred breeders and commanded top prices for their purebreds. As to cattle shows, Jack and Les have never gone the show route. Both are interested in what their cattle do on a performance-practical basis rather than in the show ring.

Les Holden was president of Montana Beef Performance Association, and both men have served as directors of the organization. Approximately 1,000 active members in MBPA were instrumental in formulating some of the first selection procedures for beef cattle improvement in the USA. All beef breeds of cattle in Montana and over large areas of the USA are now involved in similar performance testing programs, thanks to the early leadership of purebred breeders like Jack and Les.

The success story of Cooper and Holden Herefords has had a pronounced effect on the national attention which the Miles City Station has received. Recent Hereford Association sire summaries show that 16% of the highest-ranking Hereford sires tested in the USA are from Cooper and Holden herds. This attests to the prepotency of these purebreds for improving the Hereford breed. The importance of that national ranking is further emphasized when you consider that the 260 animals in the Cooper and Holden herds is less than 0.3% that of the more than 100,000 Herefords registered annually.

As members of the Montana Beef Performance Association, Jack and Les have participated actively in committee meetings to initiate programs of benefit to the commercial producers. One example was the Montana Certified Feeder program which identified top commercial herds based on performance background. Producers could obtain a premium for these cattle. This program gave strong support to the Miles City Station for their research findings and recommendations for selecting seedstock replacements.

Jack and Les have supported the idea of test stations for indexing purebred bull calves for feedlot gainability. Montana has had over 10 indexing centers in which most all breeds have been compared. The idea of the bull indexing centers has had a large impact on identifying herds of cattle for performance and for identifying high performing individual animals within most of the beef breeds. All of these indexing centers have followed guidelines for feeding bulls as originally recommended by the Miles City Station in the 1950's. The indexing centers have been a good source of herd sires for purebred herds and A.I. stud service throughout the USA.

Jack Cooper and Les Holden have received numerous recognitions for their accomplishments. They include: Outstanding Seedstock Producers Award by the National Beef Improvement Federation, Hall of Fame nomination by the American Hereford Association and Hereford Man of the Year by the Montana Hereford Association. Both men are active members of the Montana Stockgrowers Association. Jack is a member of the MSGA Liaison Committee for the Fort Keogh Livestock and Range Research Station. In this capacity, Jack has given strong support and direction to research for improving herd performance and the Line 1 birth weight project to study the effect of size of calf at birth on dystocia and herd production and for development of a strong range forage research program.

Les Holden was born November 17, 1912 in Goldfield, Nevada. He grew up and received his education through high school in Willow Creek, Montana. Les attended Billings Polytechnic Institute (now Rocky Mountain College) in Billings, Montana. Les married Ethel Eversen December 24, 1936. Les and Ethel have two sons. John raises Polled Herefords and Angus cattle on his ranch in Valier, Montana; Scott raises Hereford cattle on his ranch near Absarokee, Montana.

Jack Cooper was born September 12, 1917 in Willow Creek, Montana. He grew up and received his education in Willow Creek. Jack then returned to the ranch where he was born. He married Phyllis Garcelon October 30, 1948. Jack and Phyllis have two sons and one daughter. Mark is a partner in the Cooper cattle operation; Robert is a businessman in Billings; Lois is a homemaker in Pocatello, Idaho.

Les and Jack both give special credit (100%) to the dedicated help and cooperation of their wives, Ethel (Holden) and Phyllis (Cooper), for the wide recognition and acceptance of their Hereford herds. Ethel and Phyllis have kept track of the numerous pedigrees and performance records and maintained excellent public relations that the two purebred operations enjoy. Visitors often express how much they enjoy an opportunity to visit the Cooper and Holden ranches because of the courtesies and attention they receive.

USDA SCIENTISTS AND STAFF

Pat Currie	Research Leader and Range and Nutrition Supervisor
Linda Duncan	Secretary
Joe Urick	Animal Geneticist
Lamar Reynolds	Animal Geneticist
Bob Short	Research Physiologist
Bob Staigmiller	Research Physiologist
Bob Bellows	Research Physiologist
Don Adams	Research Range Nutritionist
Brad Knapp	Statistician
Ralph Hilderbrand	Maintenance Foreman
Janet Edmonds	Administrative Officer
Nancy Gilbertson	Purchasing Agent

MONTANA AGRICULTURAL EXPERIMENT STATION RESEARCH ASSOCIATES AND OPERATIONS STAFF

Waine Milmine	Assistant to Superintendent
Jerry Volesky	Range Research Associate
Dave Phelps	Reproductive Physiology Associate
Todd Walton	Range and Nutrition Associate

Appreciation and acknowledgement of our 30 or more support staff is also recognized. These people, employed through the Montana Agricultural Experiment Station, are the "backbone" of our research program. Without their dedication, the research presented in this booklet and at our Field Day would not be possible.

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AN AUTOMATED RANGE-ANIMAL DATA ACQUISITION SYSTEM

B. W. Knapp, D. C. Adams, P. O. Currie and J. D. Volesky

Cattle foraging on Northern Great Plains rangelands are subjected to a harsh environment due to wide fluctuations in forage and weather conditions. Also, chemical composition of range plants varies with season and weather. These variables affect grazing and resting time and the performance of range cattle. Continuous live-weight and weather data are needed to evaluate forage and environmental interactions in order to develop sound cattle management strategies and range improvement practices. Frequent movement and handling of cattle for conventional weighing are impractical because they may alter performance and/or disrupt normal activity of the animal. Also, time and labor requirements are costly. Thus, automating data acquisition can enhance data accuracy and reduce animal stress. An Automated Range-Animal Data Acquisition System, ARADS[1], was developed here at the Station to allow collection of continuous animal performance data under range conditions with minimal animal disturbance and labor input.

System Description

ARADS has 3 basic components: 1) portable electronic scales, 2) a stationary weather station, and 3) a main station central computer all linked together via a radio communication network (Figure 1). Each component operates inde-

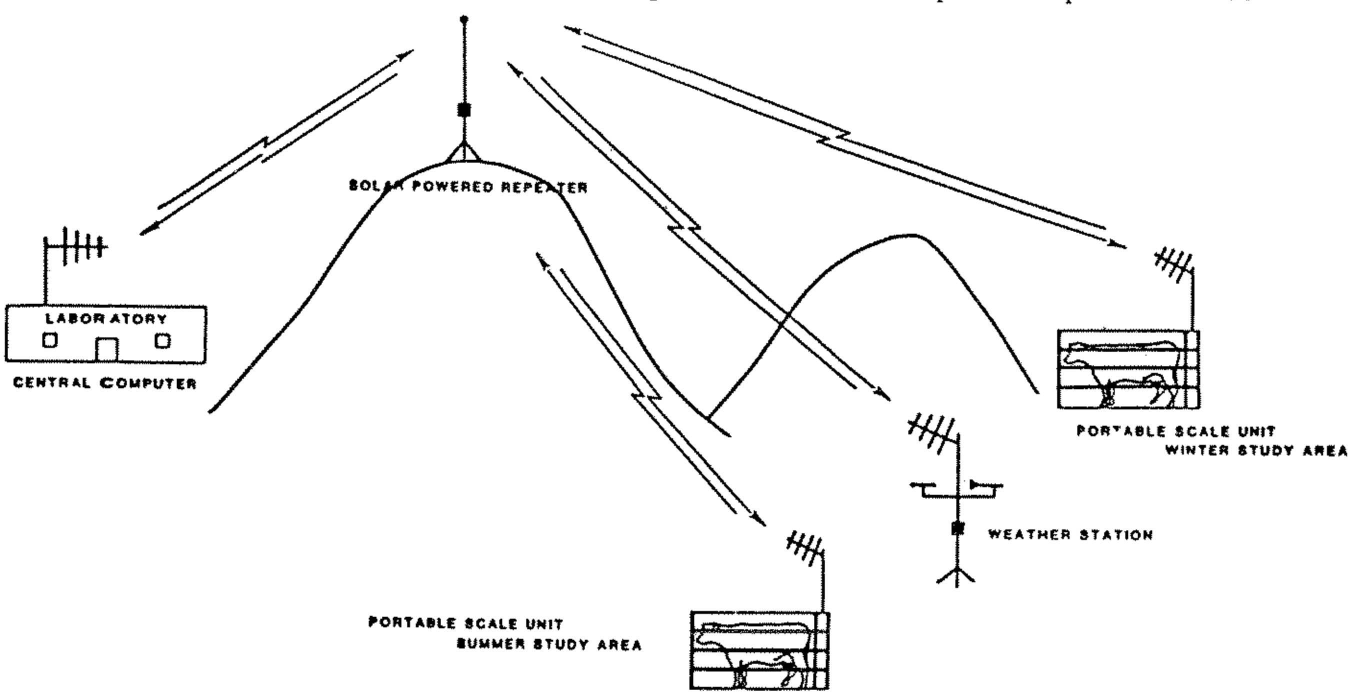

Figure 1. Schematic of the automated range-animal data acquisition system.

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[1] ARADS was developed in cooperation with GeoResearch, Inc., Billings, MT 59101 under USDA-ARS Contract 54-3K06-50. These systems are now manufactured by GeoResearch, Inc. with the trade name READS (Remote Electronic Animal Data Systems). Use of this system does not constitute endorsement by the U.S. Department of Agriculture to the exclusion of other systems.

pendently except when data transfer or control changes are required. Animals enter the scale units on a free-choice basis to gain access to drinking water. Water under pressure is metered into self-filling water bowls by electronic flow meters to determine consumption. Each scale is equipped with an electronic animal identification interrogator which recognizes individual transponders attached to the ear of each animal. The identification transponders are encapsulated in plastic discs approximately 1 1/4 X 3/8 inches weighing a few ounces. The discs are attached to the ear by commonly available plastic ear tag buttons. Millions of individual transponder identification codes are possible. Live weight is measured at the times an animal enters and exits the scale. The difference between entry and exit weights provides a cross check on water consumption measurements. The system is designed to zero the scale after recording live-weight data for each animal. Time and date of each measurement event are also recorded, allowing utilization of the data in behavioral investigations.

Animals enter and exit from the rear of the scale. To prevent animals outside of the scale from distorting weights, the scale is enclosed by panels on the front. The scale is equipped with an air-powered gate at the rear which closes behind each animal. This ensures that only one animal is weighed at a time. Photocells determine when the gates should open and close and initiate the measurement cycle. One scale unit has served up to 40 animals without difficulty.

The present scale units are portable between fall-winter and spring-summer grazing locations. Each study site has AC power and a pressurized water supply. The scale unit is leveled and securely fastened to a concrete pad before data collection. The microprocessor scale controllers are housed in weatherproof enclosures and include backup batteries to prevent data loss during AC power interruptions. Load cells on the scales are mounted overhead to keep the load cells clear of mud and snow. Scale decks are equipped with electrical heating elements so that ice and snow buildup can be removed as needed. During winter, water in each water bowl is heated to prevent freezing. In the event of power failure, the water pipes drain automatically. The maximum length of each weighing platform is approximately 10 feet, but the length can be shortened for smaller animals by moving the water unit toward the back of the scale. Additional scale units or weather stations can be added to the present system.

The weather station is located centrally between the fall-winter and spring-summer study units. Weather variables measured include ambient air temperature, precipitation, wind direction, wind speed, solar radiation, humidity, barometric pressure, soil temperature, and snow particle frequency and diameter. Weather data are recorded at 2-second intervals but hourly averages are maintained on a microprocessor at the weather station.

Each scale unit and the weather station are equipped with a 5-watt radio for transmitting data to the computer located at the main office building approximately 5 miles from the study sites. The radio signal is sent from the data generating units through a radio relay located on a high point. Communication is bidirectional and control settings can be changed from the central computer. The central computer accesses each data generating unit as required to generate data files for analysis.

Utilization of ARADS

ARADS was installed during the fall and winter of 1985-86, and ARADS has been used with cows under harsh winter conditions and was used for obtaining daily weights on steers during the summer. All systems performed satisfactorily during both winter and summer use. During the winter use, snow was present on the ground and ambient air temperatures dropped below -20°F and during the summer, air temperatures were in excess of 98°F.

Before cattle used the ARADS, a training stall similar to the scale units was fabricated and animals were given time in drylot to acquaint themselves with the weighing and drinking procedure. After this, a period of only 2-3 days was required for animals to accept the scale units in the field. Some animals chose to eat snow rather than drink; however, once an animal drank from the unit, the procedure became routine and did not appear to be a problem.

We anticipate that ARADS will greatly enhance data collection at the USDA-ARS Research Laboratory at Miles City and will provide a significant technological means of improving range-animal research. Plant-animal-weather interactions can be studied in detail without disrupting individual animal activities. The continuous body weights and weather records provide a means for developing range-livestock models and allow evaluation of the environment for both plants and animals to optimize cattle management strategies and range improvement practices. A number of unexpected animal-grazing behavior responses have already been shown which are contrary to commonly accepted belief.

EFFECTS OF MULTIPLE RANGE RENOVATION PRACTICES ON FORAGE PRODUCTION AND LIVESTOCK PERFORMANCE

P. O. Currie and J. D. Volesky

Approximately 50% of rangeland in the Northern Great Plains is classified by the Soil Conservation Service (SCS) as fair or poor condition range. Improving these rangelands is of major economic importance to livestock producers attempting to upgrade their operations. Much of this rangeland can be renovated by mechanical manipulation and the introduction of improved forage species. This report focuses on range renovation research conducted at two sites on the Fort Keogh Livestock and Range Research Station from 1982 to 1986.

Treatments and Study Sites

Seven treatment pastures and a control pasture were established in 1982 on each of two range sites that were in fair to poor condition. Each pasture is approximately 30 acres in size. The upland site (Upper Cottonwood) is on a well-drained, silty clay loam soil with needleandthread (*Stipa comata*), threadleaf sedge (*Carex filifolia*), Sandberg's bluegrass (*Poa sandbergii*) and western wheatgrass (*Agropyron smithii*) as the major forage producing species. The second site (North 2B) is on a heavy clay soil (with claypan spots) and has western wheatgrass and blue grama (*Bouteloua gracilis*) as major forage producing species. The introduced annual grasses, cheatgrass brome (*Bromus tectorum*) and Japanese brome (*B. japonicus*), are also common at both study sites.

Six pastures at each site were treated using a prototype Range Improvement Machine (RIM) developed here at the Station. This unit tills the soil, forms a vee-trough seedbed and plants in a single-pass operation. The soil tillage is accomplished with a rototiller. A notched packing wheel assembly forms 5-inch deep furrows with intermittent check dams for water retention and control. Furrows are spaced 20 inches apart. A modified commercial drill is fixed immediately behind the packing wheel assembly and is equipped with double disc openers with depth bands on both sides of the openers to control seed placement. The openers are followed by standard rubber-tired seed packing wheels. The RIM is also equipped with a box for granular fertilizer which is independently metered and top dressed in front of the double-disc openers.

To increase productivity through nitrogen fixation, a dryland alfalfa (Medicago falcata)[1] and cicer milkvetch (Astragalus cicer) were seeded into four of the RIM treated pastures at each site. Seeding rate was 2 pounds/acre for each species. Sagebrush, primarily big sagebrush (Artemisia tridentata wyomingensis), was controlled on three of the interseeded pastures at Upper Cottonwood by applying 2.5 pounds/acre of 2,4-D. Mechanical chopping during the winter was used to control the sagebrush at the North 2B site. One RIM treated pasture at each site was not interseeded but fertilized with 50 pounds/acre of elemental nitrogen.

Contour furrows were established in one pasture using a lister-type shovel. The flat-bottomed furrows were 20 inches wide and about 3 inches deep. Approximately 40% of the soil surface area was disturbed by both the contour furrow and RIM treatments. The contour furrowed pastures were aerially seeded with 4 pound/acre each of alfalfa and cicer milkvetch.

Six of the eight pastures were grazed season long while two pastures were alternately grazed with twice the number of animals for one-half of the season.

A summary of pasture treatments or treatment combinations and their grazing plans are as follows:

1. Control, grazed season long.
2. RIM intertilled only, grazed season long.
3. RIM intertilled, seeded with legumes, grazed season long.
4. RIM intertilled, seeded 2 pounds/acre, brush control, grazed season long.
5. RIM intertilled, fertilized 50 pounds/acre N, grazed season long.
6. Contour furrows, aerially seeded with legumes 4 pounds/acre, grazed season long.

7 & 8. RIM intertilled, seeded with legumes, brush controlled, 2 pastures grazed alternately.

[1] Spreador 2 alfalfa and lutana cicer milkvetch were the plant varieties used.

The 30-acre experimental pastures were stocked with 5 yearling steers with an average initial weight of about 675 pounds. Grazing periods were planned to last 90 days and started around the third week of May at the Upper Cottonwood site and 2 weeks later at the North 2B site.

Results

Grazing was for 90 days at both sites in 1983, but drought conditions during 1984 and 1985 forced a reduction in the length of the grazing period to 60 and 40 days for these 2 years, respectively. The length of grazing season was again increased to 90 days in 1986 except on the control treatment in North 2B. This treatment would only support animals for a 76-day grazing season. Daily gains of the steers at the North 2B site averaged for all 4 years were highest in the contour furrow and RIM + seeded + brush control (grazed season long) treatments (1.9 pounds/day; Table 1). Poorest daily gains were consistently in the control pasture and averaged 1.1 pounds/day over the 4 years. Daily gains at the Upper Cottonwood (upland site) were generally less than those at North 2B (Table 2). Differences between pasture treatments were less at Upper Cottonwood and ranged from 1.5 pounds/day in the RIM + seeded (grazed season long) and RIM + fertilized treatments to 1.1 pounds/day in the RIM + seeded + brush control (rotated) treatments.

TABLE 1. DAILY GAIN OF YEARLING STEERS (LB/DAY) NORTH 2B STUDY LOCATION. 1983, 1984, 1985, 1986 GRAZING SEASONS

Treatment	Year				$\bar{X}$
	1983[1]	1984[2]	1985[3]	1986[4]	years
1. Control	0.9	1.5	0.5	1.4	1.1
2. RIM (tilled only)	1.3	2.1	1.0	1.6	1.5
3. RIM + seeded (season long)	1.4	1.9	0.9	1.7	1.5
4. RIM + seeded + brush control (rotated)	1.5	2.2	1.6	1.7	1.7
5. RIM + seeded + brush control (season long)	1.6	2.1	1.4	2.4	1.9
6. RIM + fertilized	1.6	1.9	1.3	1.6	1.6
7. Contour furrowed	1.6	1.9	1.8	2.2	1.9

[1] 90-day grazing period.
[2] 60-day grazing period.
[3] 40-day grazing period.
[4] Daily gain through 76 days. Steers grazed an additional 20 days in all treatments except the control.

The daily gains of the yearling steers varied sharply between the first and second halves of the grazing season. In 1983 and 1986, the 2 years with 90-day grazing periods, gains were well over 2 pounds/day in all treatments during the first 45-day period from early June to mid July. Gains the last 45 days of the season from late July to August averaged 0.5 pounds or less per day and some steers lost weight, especially those at the Upper Cottonwood site. Diet collections from fistulated animals showed these decreases in daily gain were primarily associated with a decrease in quality of forage available during the latter part of the summer.

TABLE 2. DAILY GAIN OF YEARLING STEERS (LB/DAY) UPPER COTTONWOOD STUDY LOCATION. 1983, 1984, 1985, 1986 GRAZING SEASONS.

Treatment	Year				$\bar{X}$ years
	1983[1]	1984[2]	1985[3]	1986[1]	
1. Control	0.9	1.7	1.4	0.9	1.2
2. RIM (tilled only)	0.7	1.4	2.1	0.8	1.3
3. RIM + seeded (season long)	1.1	1.8	2.0	1.1	1.5
4. RIM + seeded + brush control (rotated)	0.6	1.4	1.4	1.0	1.1
5. RIM + seeded + brush control (season long)	0.6	1.5	2.2	1.4	1.4
6. RIM + fertilized	0.9	1.5	2.0	1.4	1.5
7. Contour furrowed	0.6	1.9	1.8	1.0	1.3

[1] 90-day grazing period.
[2] 60-day grazing period.
[3] 40-day grazing period.

The range manipulation treatments had a pronounced effect on herbage yields. Yields for treated pastures for the 4 years averaged from 153 to 446 pounds/acre more than control (Tables 3 and 4). At the North 2B site, average yields in the contour furrow and RIM + seeded + brush control (rotated, first pasture) treatments were almost twice those of the control. The contour furrow treatments, however, resulted in the least herbage response at the Upper Cottonwood site, indicating that type of treatment to be more useful on the heavier clay soils (North 2B) rather than the well-drained soils typical of the Upper Cottonwood site.

TABLE 3. TOTAL HERBACEOUS YIELD (LB/AC) NORTH 2B STUDY LOCATION. 1983, 1984, 1985, 1986 GRAZING SEASONS.

Treatment	Year				$\bar{X}$ years
	1983	1984	1985	1986	
1. Control	582	476	257	566	470
2. RIM (tilled only)	633	522	417	918	623
3. RIM + seeded (season long)	865	584	402	1074	731
4. RIM + seeded + brush control (rotated)	1025	670	513	1455	916
	915	614	295	894	680
5. RIM + seeded + brush control (season long)	933	894	425	1157	852
6. RIM + fertilized	1014	441	315	902	668
7. Contour furrowed	840	609	879	1279	902

TABLE 4. TOTAL HERBACEOUS YIELD (LB/AC) UPPER COTTONWOOD STUDY LOCATION. 1983, 1984, 1985, 1986 GRAZING SEASONS.

Treatment	Year				$\bar{X}$
	1983	1984	1985	1986	years
1. Control	660	233	214	578	421
2. RIM (tilled only)	1205	302	300	794	650
3. RIM + seeded (season long)	1114	425	343	759	660
4. RIM + seeded + brush control (rotated)	1152	462	405	704	681
	1179	220	292	792	621
5. RIM + seeded + brush control (season long)	1291	519	308	723	710
6. RIM + fertilized	1438	408	335	861	761
7. Contour furrowed	931	366	264	765	582

The RIM + fertilizer treatment resulted in excellent herbage yields the first year after application in 1983, but yields sharply dropped the following 2 years. Yield on this treatment again increased in 1986, reflecting the interaction which occurs with rainfall. This influence of water was also reflected in the RIM only treatments. The soil disturbance and water-trapping furrows from the RIM (tilled only) treatment resulted in 33 and 54% greater average herbage yield than the control.

Establishment of the alfalfa and cicer milkvetch initially was quite good at the Upper Cottonwood site, but the legumes died out and the two species only accounted for 1 to 2% of the total herbage production in any of the seeded pastures. Alfalfa establishment was fairly successful in heavier clay soils of the North 2B site. Milkvetch establishment was, however, not successful. Alfalfa accounted for 15 to 30% of the total herbage production in 3 of the 4 seeded pastures and has consistently increased in the contour furrows. Poorer alfalfa establishment was observed in the RIM + seeded (grazed season long) treatment probably because of soil differences.

Increases in animal productivity were associated with the increased herbage production as well as an overall increase in forage quality in those pastures that had legume establishment. Stocking rates were maintained at a constant level for all pastures during the first 4 years of study. However, in 1987 variable stocking rates were applied. It appears the increased herbage production and higher quality forage obtained will support higher stocking rates and a greater return in pounds of beef/acre.

EFFECTS OF NATIVE AND IMPROVED RANGE ON REPRODUCTION AND PERFORMANCE OF BEEF COWS

D. C. Adams, R. B. Staigmiller and B. W. Knapp

Improved rangelands in the Northern Great Plains are important grazing resources. Crested wheatgrass is an introduced cool season grass which produces more forage per acre than native grasses (Smoliak and Dormaar 1985) and is more resistant to damage from early spring grazing than most native species in the Northern Great Plains (Wight et al. 1983). Russian wildrye is another introduced cool season grass noted for its productivity (Smoliak and Dormaar 1985), palatability and forage quality durng the late summer and fall (Wight et al. 1983). Contour furrowing is a range improvement practice that increases water infiltration (Neff 1973) of range soils and increases forage production on native rangeland (Kartchner et al. 1983).

Production characteristics of crested wheatgrass, Russian wildrye and contour furrows are well defined in the literature. However, little attention has been given to the effects of these grasses and the use of contour furrowing as they relate to total performance of beef cattle (cow and calf). Objectives of our study were to compare reproductive performance of cows and productivity of calves grazing native range to systems utilizing crested wheatgrass during the prebreeding period and Russian wildrye and contour furrowed native range during the breeding period.

Research Methods

One hundred eighty and one hundred fifty acres of native rangeland were plowed and seeded to crested wheatgrass and Russian wildrye grass, respectively. In addition, 180 acres of native rangeland were contour furrowed with a lister type plow and seeded with Ladak alfalfa as described by Kartchner et al. (1983). Crested wheatgrass (CW) and native range (NR) were utilized during the prebreeding period (parturition to the beginning of the breeding period). Contour furrowed native range interseeded with alfalfa (CF), Russian wildrye (RWR) and NR were grazed during the breeding season in each of 3 years as shown in Figure 1. This experimental design allowed the effects of NR and each improved pasture to be evaluated by cow and calf performance during the prebreeding or breeding season as well as the effects of the prebreeding treatments on subsequent performance in breeding pastures.

Prebreeding pastures were stocked each year when the crested wheatgrass attained a height of 5 inches (approximately April 25) and as cows calved thereafter. Cows grazed the prebreeding pastures until approximately 2 weeks before the beginning of the breeding season (approximately June 1). Cows and calves were then sorted into breeding pastures. The number of cows which had not yet begun normal estrous cycles after calving was determined at the start of the breeding season. On June 15, breeding bulls were turned in and remained for a 45-day period.

Cows and calves were weighed at the beginning of the prebreeding period, at the end of prebreeding period (beginning of breeding), at the end of the breeding period and at weaning. Cows were also condition scored on a scale of 1 to 10 with 1 being thinnest and 10 being fattest at the dates described for body weights. Milk production was determined for a 12-hour period for each cow by the calf weigh-suckle-weigh technique. These measurements were made at the beginning and ending of the breeding season and at weaning.

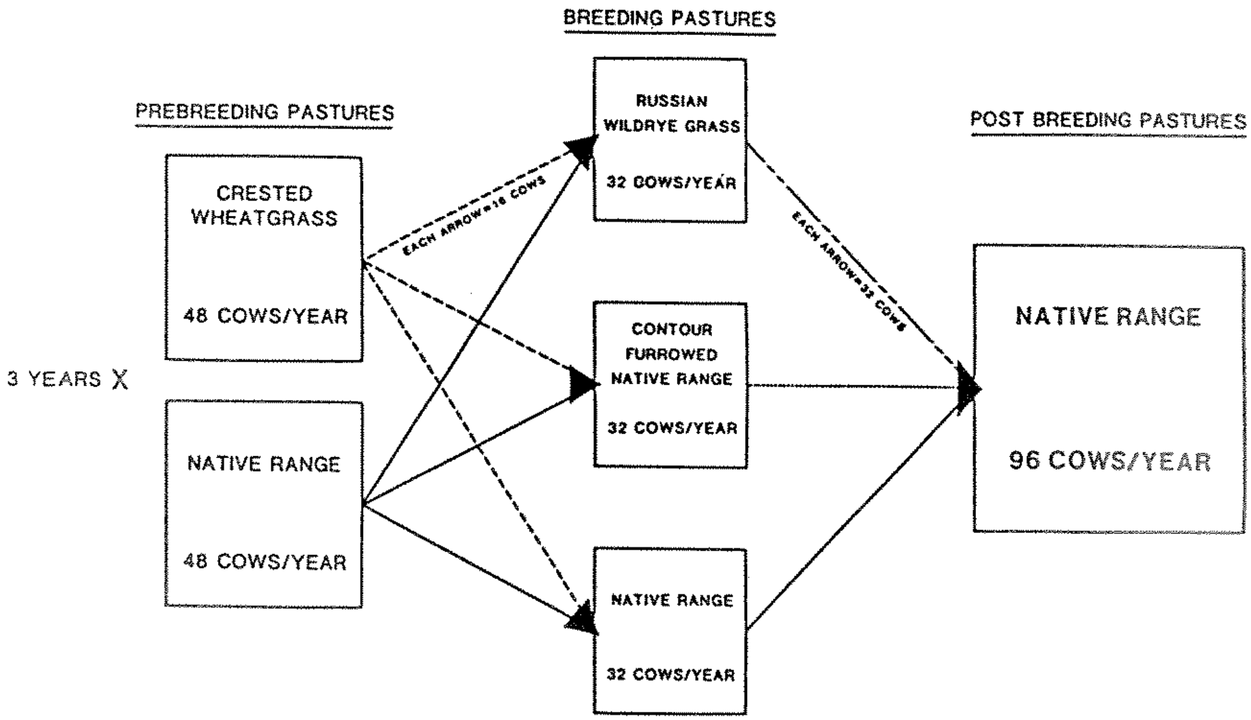

Figure 1. Experimental design for evaluating improved and native rangeland for beef cows during the prebreeding and breeding periods.

Results

Reproductive performance of the cows is summarized in Table 1. Prebreeding and breeding forage treatments did not significantly affect the number of cows in estrus before the beginning of breeding, the fall pregnancy rate or the date of parturition the following spring. The fall pregnancy rate for cows in all treatments was over 90% in each of the 3 years.

TABLE 1. REPRODUCTIVE PERFORMANCE OF COWS GRAZING NATIVE AND IMPROVED RANGE DURING THE PREBREEDING AND BREEDING PERIODS.

	Prebreeding pasture		Breeding pasture		
Item	Native range	Crested wheatgrass	Native range	Russian wild ryegrass	Contour furrowed native range
Cows in estrus before the beginning of the breeding period, %	87.0	84.2	--	--	--
Fall pregnancy rate	94.4	90.3	92.2	91.5	93.3
Date of parturition	106	103	105	104	105

Change in body weight and body condition score of the cows from prebreeding to weaning are shown in Figures 2 and 3, respectively. Cows which grazed CW gained 20 pounds more per cow than did cows grazing NR during the prebreeding period. This weight advantage was maintained to weaning. The CW cows also gained more body condition during the prebreeding period than did those grazing NR. Cows in each of the three breeding treatments gained weight during the breeding season and then lost weight from the end of the breeding season to weaning. The loss of weight between the end of the breeding period and weaning is best explained by the advanced maturity of the forage and the maintenance requirements for grazing and lactation. Weight gains of cows during the breeding season were greatest for cows grazing in the CF and lowest for those on NR. Cows on the CF and RWR treatments tended to gain more body condition than cows on the NR range treatment but differences in body condition changes during the breeding season were not significant.

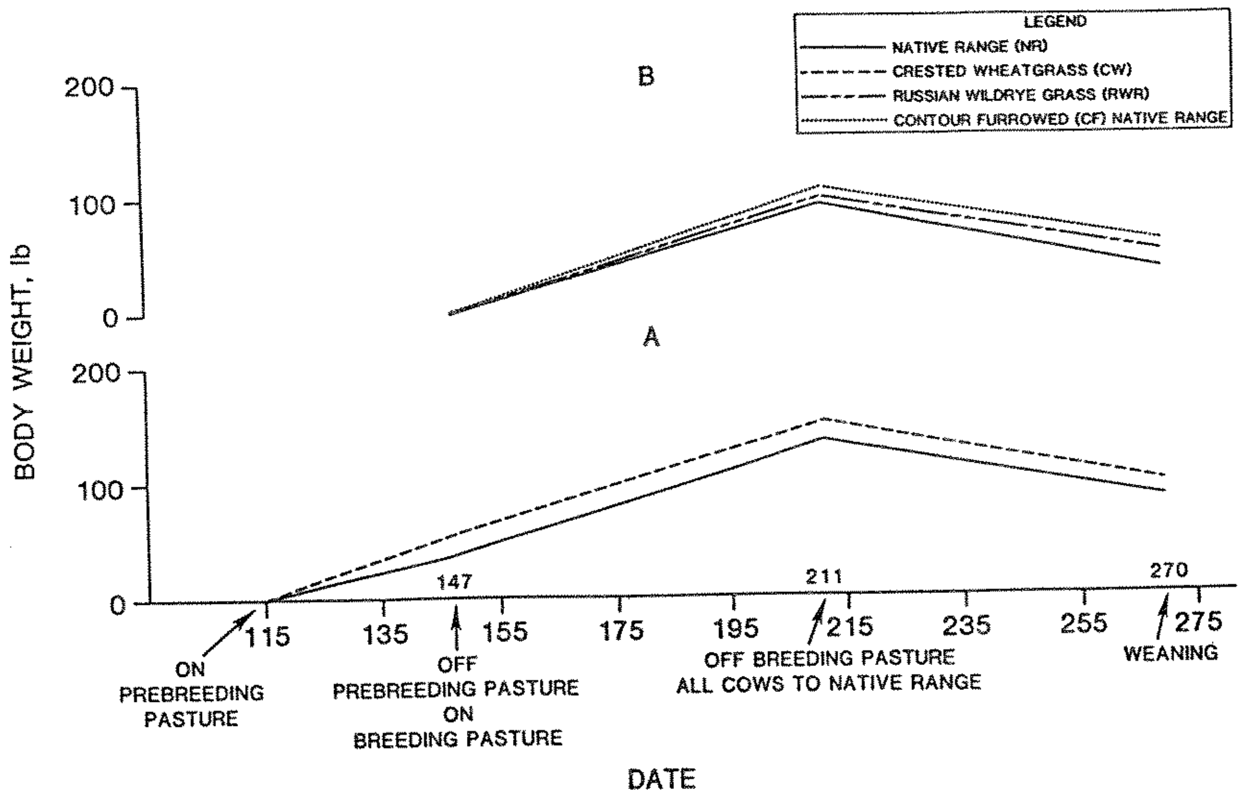

Figure 2. Effect of prebreeding (A) and breeding (B) pasture treatments on weight change of cows.

Average milk production per cow was 9.7, 8.3 and 2.2 pounds for a 12-hour period, respectively, at the beginning and end of the breeding season and at weaning. Differences in milk production between treatments were not significant at any date (Figure 4). Because of drought conditions during 2 of the 3 years of the study, the date of weaning varied from September 15 to October 5. Over the 3-year study, weaning weights of all calves averaged 447 pounds. Some differences were evident in calf gains between treatments at the various time periods, but these differences were small (Figure 5). Highest gains were noted for CW during the prebreeding period and CF during the breeding period.

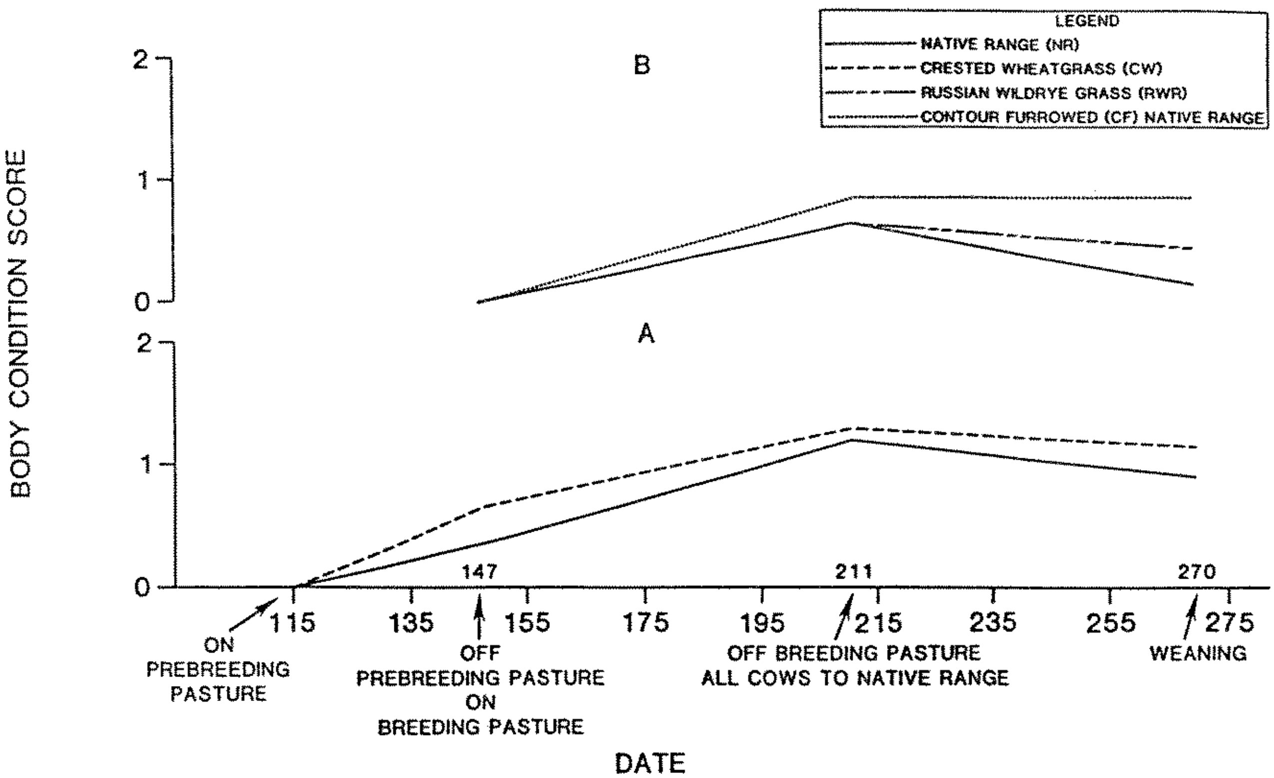

Figure 3. Effects of prebreeding (A) and breeding (B) pasture treatments on body condition change of cows.

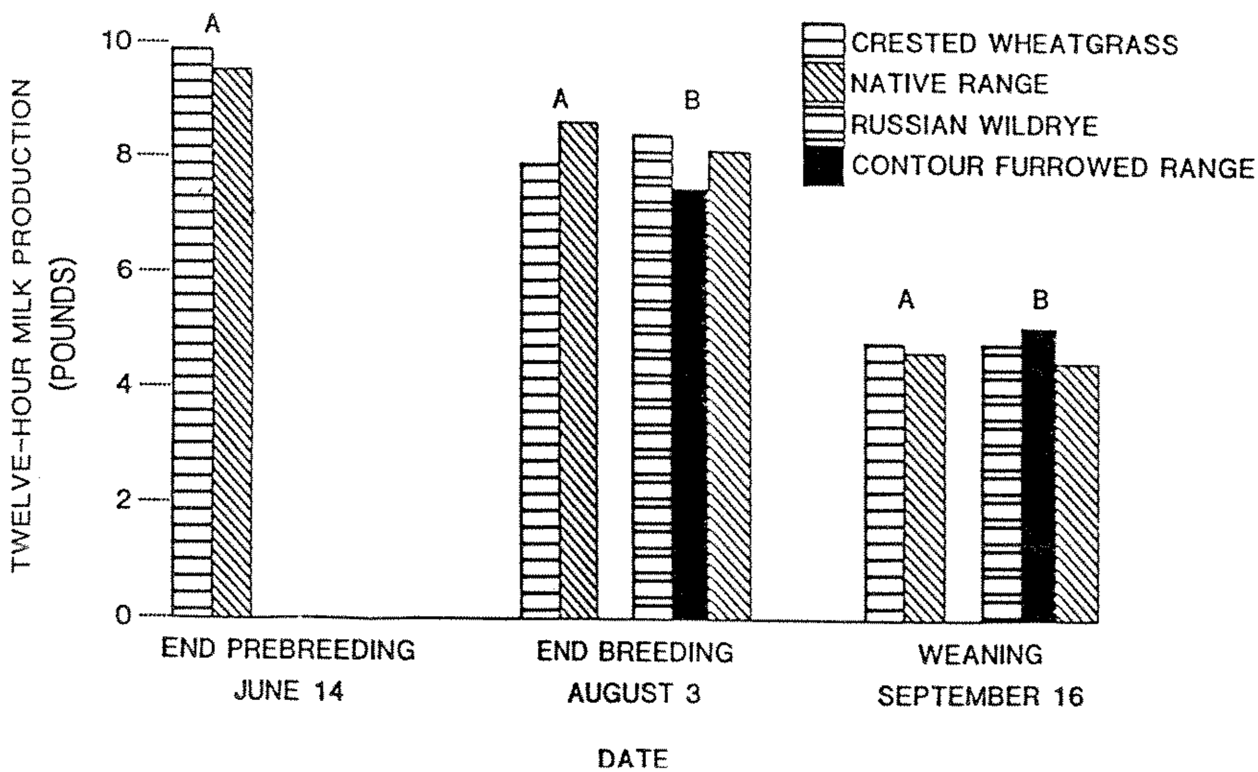

Figure 4. Effects of prebreeding (A) and breeding pasture (B) treatments on 12-hour milk production of range cows.

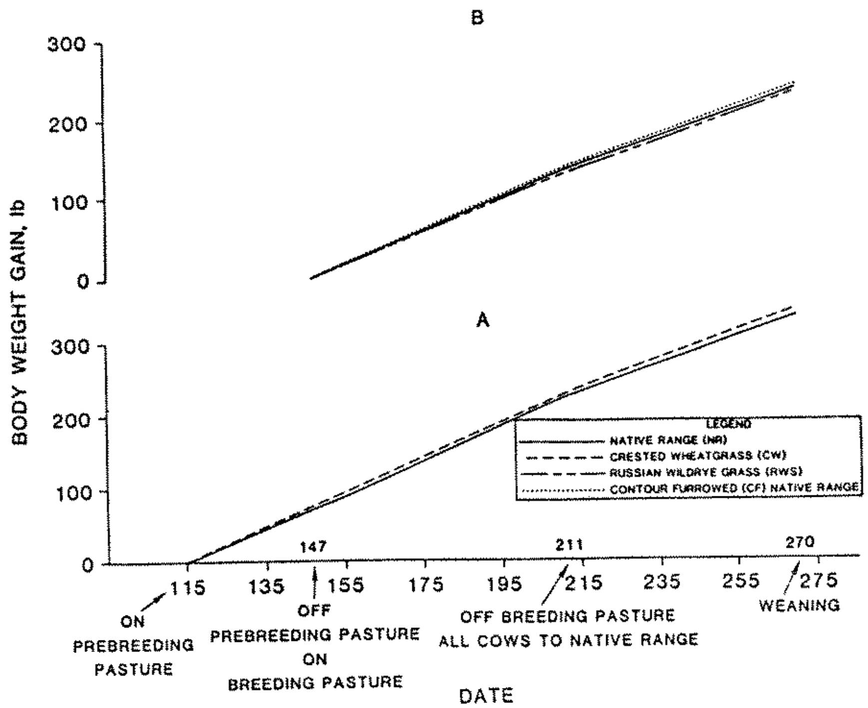

Figure 5. Effect of prebreeding (A) and breeding (B) pasture treatments on calf gains.

Conclusions

Weight gains and condition score gains were greatest for cows receiving the CW and CF during the prebreeding and breeding periods, but these differences did not translate into an advantage in reproductive performance of the cows. Small advantages in gains of the calves during the prebreeding and breeding periods were evident for calves on the CW and CF treatments respectively over the other treatments but these differences were small. From these data, we concluded that the benefits of improved pastures over NR in this study are the ability to defer grazing on NR to later in the year to an increased stocking rate and improved forage management and not an accrual to animal productivity.

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BODY SIZE AND BODY CONDITION EFFECTS ON PERFORMANCE AND BEHAVIOR OF GRAZING BEEF COWS

M. G. Ward, D. C. Adams, R. E. Short and B. W. Knapp

Cattle often graze rangeland all 12 months of the year in the Northern Great Plains. Cattlemen in this area generally calve cows during the spring. In a spring calving system, maintenance of live weight and body condition during fall-winter is imperative if cows are to rebreed at an early date. Work from this station has shown that cows which are thin at calving rebreed later in the breeding season. At Miles City, winters can be extremely harsh. Temperatures as low as 0 F have been recorded as late as April 1 and as early as October 28. Work from this station has shown intake and digestibility of range forage to be drastically reduced at colder temperatures with weight loss being common in cows consuming range forage only.

In order to achieve optimum utilization of fall-winter range and maintain peak reproductive efficiency, relationships between the cow and environment must be clearly understood. A continual goal of nutrition research at this laboratory is the determination of nutrient requirements and proper management practices during fall-winter periods, thus enabling cattlemen to produce beef more efficiently. To date, effects of body condition and body size on performance and behavior of cows grazing fall-winter rangeland are poorly understood. Our objectives in the present study were to determine effects of cow body size and body condition on forage intake, body weight gain and behavior during fall-winter on rangeland.

During late summer of 1982, 132 pregnant crossbred cows were assigned to groups of large, medium and small body size on the basis of live weight. Fifty-two cows were randomly selected from the large (N=26) and small (N=26) body size groups for experimental animals. Large (L) and small (S) cows (average body weight = 1266 and 1003 pounds, respectively) were fed either a high or low energy diet in drylot for 82 days to create four groups of cows differing in body size and body condition (i.e., L-thin, L-fat, S-thin, S-fat). Diets consisted of corn silage and soybean meal and were formulated to meet 125 and 75% of the energy requirements for maintenance. Following the 82-day drylot period, all cows grazed a common 1003-acre pasture from 26 October 1982 to 17 January 1983. Body condition scores were recorded for each cow at the beginning and end of the study based on a palpated determination of fleshing over the ribs and thoracic vertebrae. Condition scores (1=thinnest; 10=fattest) were an average from two independent estimators.

Four cows from each treatment were fitted with 8-day vibration recorders. The recorder is strapped to the cow's neck and operates self-sufficiently without external power. When the head of the cow is down in a grazing position, the device transfers the swinging movements of the head from grazing onto a recording chart by means of a pendulum and stylus. Grazing time was monitored continuously from 23 November 1982 to 16 January 1983 using this instrumentation and technique. Two 5-day intake trials were conducted beginning 5 December and again on 23 December. These are denoted as trials I and II, respectively. Forage intake was determined using chromic oxide as an external marker to estimate fecal excretion and acid detergent lignin as an internal marker to estimate forage digestibility. During the intake trials, two 770-

pound steers were fitted with fecal collection bags and grazed concurrently with the cows. Chromic oxide was used to adjust the fecal output estimates. Eight esophageally fistulated steers with an average body weight = 1100 pounds were turned in to graze concurrently with the cows on 14 November, 5 December and 2 January. After two days, fistula forage samples were collected and chemically analyzed for acid detergent lignin, acid detergent fiber and crude protein.

Weather during the study was mild for this time period. Over the study period, temperatures averaged 15 F with a low of -9 F being recorded. Snow fall was light and snow depth during the study approximated 6 inches. Chemical composition of fistula forage samples are shown in Table 1. As expected, acid detergent fiber increased, acid detergent lignin remained constant and crude protein decreased with advancing forage maturity. Forage intake was greater for L than S cows and similar for fat (F) and thin (T) cows when expressed as pounds/day (Table 2). When analyzed on a pounds of intake/100 pounds of body weight basis, forage intake was greater for S than L cows and similar for F and T cows. Forage digestibility was similar for all cows (Table 2). Daily grazing time averaged 8.3 hours/day and was similar for all cows. As temperatures became colder, all cows grazed less. Small cows grazed more than L cows at warmer temperatures but less at colder temperatures (Figure 1). This agrees with previous work conducted at this station in which low air temperatures were shown to negatively affect grazing time with S or young cows being more affected and thus grazing less than L or older cows.

TABLE 1. CHEMICAL COMPOSITION OF FISTULA FORAGE SAMPLES FROM FALL-WINTER RANGE[a].

Item	Date		
	16 November	7 December	4 January
	%		
Organic matter	88.9	91.2	92.6
Acid detergent fiber	49.8	50.1	54.5
Acid detergent lignin	4.5	4.6	4.5
Crude protein	4.6	3.3	2.8

[a] Dry matter basis.

Body condition scores were similar for all cows before energy treatments were imposed (Table 3). At the beginning of the grazing study, body condition scores were greater for L than S cows and F than T cows. During the grazing period, all cows lost body condition. Body condition scores were greater for L than S cows and F than T cows at the conclusion of the study. It should be noted, however, that change in body condition score from beginning to end of the grazing period was similar for all cows. Large cows were heavier than S cows with T and F cows being similar in body weight before energy treatments were imposed (Table 3). At both the beginning and end of the grazing period, L and F cows were heavier than S and T cows, respectively. Over the 81-day grazing period, L and F cows lost more weight than S or T cows, respectively.

TABLE 2. DRY MATTER INTAKE AND DIGESTIBILITY OF FALL-WINTER RANGE FORAGE FOR COWS OF DIFFERENT BODY SIZE AND CONDITION[a].

	Body Size		Body Condition	
Item	Small	Large	Thin	Fat
Forage intake (lb/day)	17.3	18.7*	18.3	17.6
Forage intake (lb/day/100 lb body wt)	1.74	1.50**	1.65	1.59
Forage digestibility	40.5	39.0	39.9	39.6

[a] Dry matter basis.
* Means within main effect of body size or body condition differ P<0.05.
** Means within main effect of body size or body condition differ P<0.01.

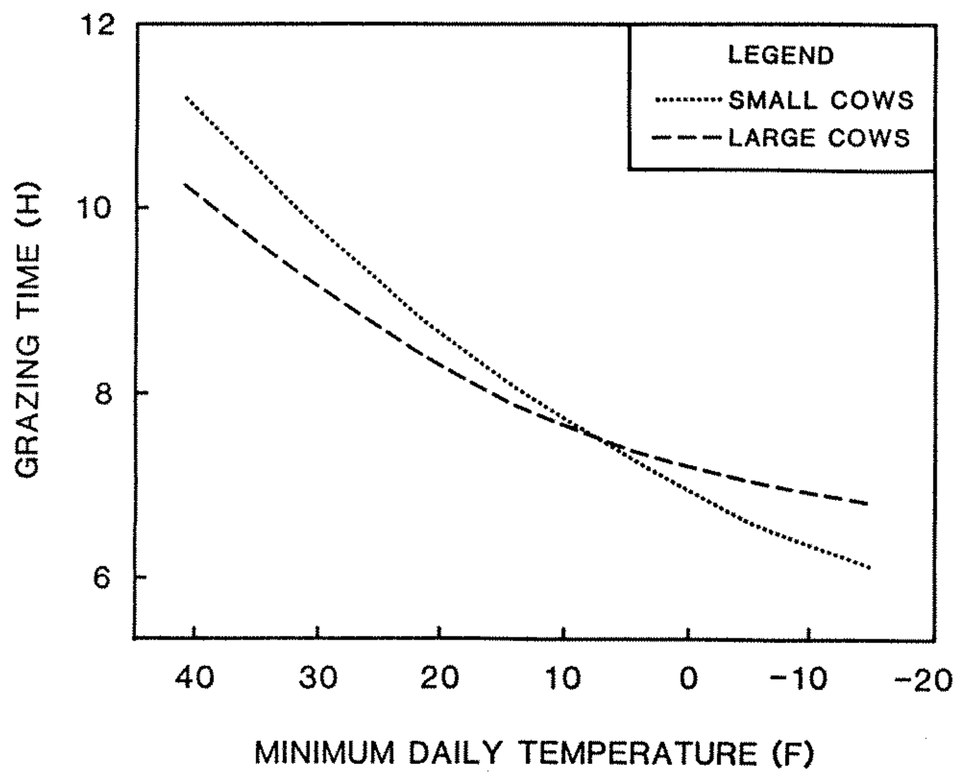

Figure 1. Daily grazing time of cows of different body size at different air temperatures.

TABLE 3. BODY CONDITION SCORE AND LIVE WEIGHT CHANGE FOR COWS OF DIFFERENT BODY SIZE AND BODY CONDITION.

	Body Size		Body Condition	
Item	Small	Large	Thin	Fat
Body condition scores				
Before drylot treatments	4.9	5.9	5.3	5.5
Beginning of study	5.2	5.8*	5.0	6.1**
End of study	3.9	4.8**	3.9	4.8**
Change in body condition score during study	-1.3	-1.0	-1.1	-1.1
Live weight	----------lb----------			
Before drylot treatments	981	1263**	1122	1124
Beginning of study	1003	1241**	1074	1173**
End of study	968	1185**	1036	1118**
Change in live weight during study	-35	-56**	-38	-55**

* Means within main effect of body size or body condition differ $P<0.05$.
** Means within main effect of body size or body condition differ $P<0.01$.

Forage intakes observed in the current study were below recommended allowances for beef cattle and were lower than expected for the moderate weather conditions encountered during the trial. We believe reduced intake resulted primarily from the low protein concentrations observed in the fistula forage samples. Previous work from this station shows forage protein concentrations observed in the present study were below normal in regards to recommended allowances for maintenance requirements of beef cattle. The higher absolute forage intake of L than S cows was expected and is attributed to L cows having greater rumen capacity. An explanation for the higher intake per unit of live weight for S than L cows is not readily apparent. As stated previously, forage intake when expressed on a body condition basis was similar for F and T cows on both an absolute and per unit of body weight basis. However, previous data from this station indicates that differences in body condition will affect estimates and interpretation of forage intake when intake is expressed on a body weight basis.

Nonsupplemented cattle foraging on fall-winter rangeland in the Northern Great Plains commonly lose live weight and body condition. In our study, although S and T cows lost less weight than L and F cows, respectively, all cows lost similar amounts of body condition. Cows beginning the study in high body condition (F cows) maintained this body condition advantage over cows in low body condition throughout the study regardless of body size. Since interval from calving to first estrus and pregnancy is closely related to body condition, we feel cow body condition is a critical consideration when formulating fall-winter management procedures. Consequently, it appears most advantageous to manage cows during late summer and early fall so that body condition is maintained at a moderate level.

EARLY WEANING AND ARTIFICIAL REARING OF BEEF CALVES

Robert B. Staigmiller and Don C. Adams

The Problem

During the last decade, southeastern Montana has experienced a number of years of moderate to severe drought conditions. Several consecutive years received approximately two-thirds or less of the average annual precipitation for this area. Under conditions this severe, cattle producers are faced with difficult decisions about both the short and the long-term use of their animal and range resources. They must maintain the long-term forage productivity of their range lands and at the same time maintain an animal inventory that will provide them with at least a subsistence income until conditions improve.

Early spring rains in 1985 provided adequate early growth of forages on the ranges in southeastern Montana, but a lack of rain after mid-May resulted in limited growth and early maturation of the available forage. Hence, by mid-June, it became obvious that the ranges would not support the stocking rates established earlier in the spring. The objective of the following study was to evaluate a management plan that would permit producers to remove the grazing pressure from drought impacted summer ranges, and at the same time, minimize the financial loss that would be incurred.

The Study

Cows and their calves were removed from the range on July 3, and the calves were weaned and put in the feedlot. At weaning, the 37 steer and 30 heifer calves averaged 83 days of age. Three different diets were tested for their ability to produce gains on these calves over the next 84 days. Diets were selected from feedstuffs commonly available or produced on Eastern Montana ranches. Calves were fed either whole barley, rolled barley or whole oats. Calves had free access to their assigned grain, as well as good quality alfalfa hay, a salt-mineral mix and fresh water.

Results

The calves averaged 306 pounds at the start of feeding, and 476 pounds at the end. Calves on rolled barley gained 2.2 pounds/day, which was slightly faster than the 2.1 pounds/day for calves fed whole barley (Table 1). Both barley groups, however, gained faster than calves on whole oats (1.8 pounds/day). Steers gained only slightly faster (2.1 pounds/day) than heifers (2.0 pounds/day).

The difference in rate of gain between the three diets is best explained by total feed intake during the feeding period. Total intake was greater for animals consuming barley diets than the oat diet. Most of the difference was in the amount of grain consumed, although hay intake was also somewhat lower for calves on the oat ration. The higher rate of gain with the barley diets was the result of two factors. First, the calves ate more on the barley diets than on the oat diet. Second, barley has a greater energy density or more energy per pound than does oats.

TABLE 1. PERFORMANCE OF EARLY WEANED BEEF CALVES ON THREE DIFFERENT GRAIN RATIONS.

Item	Diet		
	Whole Barley	Rolled Barley	Whole Oats
Average gain for 84 days (Pounds per calf)	176	185	151
Average daily gain (Pounds per day)	2.1	2.2	1.8
Total grain intake (Pounds per calf for 84 days)	719	669	626
Total hay intake (Pounds per calf for 84 days)	173	169	152
Total intake for hay and grain combined (Megacalories of ME per calf)**	1151	1079	930
Feed efficiency** (Megacalories of ME per pound of gain)	6.5	5.8	6.2
Cost of gain/calf**	.25	.26	.34
Value live weight ($ per animal)**	$337.40	$343.70	$319.90

** See text for explanation of why megacalories of ME are used for Total Combined Intake and Feed Efficiency, and for feed costs and calf prices used in the Economic Summary.

Feed efficiency is a measure of how much feed it takes to produce a pound of gain. We can not get a good estimate for feed efficiency by simply adding the pounds of grain to the pounds of hay, because not all animals eat hay and grain in the same proportions, and grain provides much more energy than hay. We can get a good estimate of feed efficiency by combining the energy of the grain with the energy of the hay and dividing the total by the pounds gained. Energy is expressed as metabolizable energy (ME) and the unit of energy used is "megacalories" which is equal to one million calories. These values are shown in Table 1. Remember that a lower number is "better" since it means that fewer megacalories of energy are required for each pound of gain.

In our study, the best feed efficiency was with rolled barley, while whole barley and whole oats were the same. This is not surprising, since almost any processing that breaks the grain kernals makes the energy more easily digested.

Economic Summary

To evaluate different diets from the standpoint of costs, we called a local feed dealer and obtained costs of the feeds used in our study. On August 1, 1987, barley cost $5.10 per hundred weight (cwt), rolled barley was $6.20/cwt, oats was $7.30/cwt and alfalfa hay was $4.00/cwt ($80.00 per ton). We arbitrarily assigned 70¢ per pound as the market value of calves at weaning in the fall. Using these values, we calculated the cost of a pound of gain for each of the diets, and a value for the liveweight of calves for each diet. These values are also shown in Table 1. Although there was an additional cost of $1.10/cwt for rolled barley, the calves gained more efficiently and the cost of gain was only 1¢ per pound different for whole and rolled barley. Both barley diets cost approximately 25% less per pound of gain than the oat diet. Comparing liveweight value of the calves at the end of the feeding period showed that calves fed whole barley and rolled barley were worth $17.50 and $23.80 more, respectively, than the calves fed oats. Also, even though it cost a penny more per pound of grain to roll the barley, the calves gained enough more to give a $6.30 greater value per animal than those fed whole barley.

It is important to remember that this economic summary evaluated only the cost of the feeds. Other costs associated with this management option must be part of the entire economic consideration. In addition, we only evaluated calf performances. The cows were sold to reduce inventory with the thoughts of rebuilding the herd when drought conditions subsided. If selling the cows is not an acceptable option, then the expense of providing for them must be included when evaluating an early weaning management plan.

METHODS OF FINISHING STOCKER STEERS RAISED ON THE RANGE

W. L. Reynolds, D. C. Adams and R. A. Bellows

Introduction

Little information is available on the growth rate of crossbred steers sired by bulls selected for growth rate when kept as stockers. Information on methods of finishing these steers to market weight and condition is limited. This study was conducted to determine the performance of crossbred steers wintered on high roughage diets, grazed on spring and summer pasture and then fed different finishing diets.

Procedures

The study utilized a total of 52 head of steers. There were 47 head of steers from weaning until beginning of the spring grazing period when 5 steers were added. Most of the steers were sired by Hereford bulls and were from dams containing varying percentages of Angus, Hereford, Charolais and Simmental breeding. The Hereford bulls were raised at the Fort Keogh Livestock and Range Research Station and selected as herd sires because of above-average growth rate. Eight calves were from Charolais bulls mated to Angus x Hereford or Red Poll x Hereford cows. The calves sired by the Hereford bulls were from dams that were 3 or 4 years of age while the calves sired by Charolais bulls were from 7-yr-old dams.

The calves were kept with their dams on pasture until weaned in October. Weaning weight ranged from 342 to 610 pounds with an average weaning weight of 502 pounds and weaning age of 178 days. After weaning, steers were placed in drylot and fed a high roughage diet for 35 days. They were then placed in a small pasture and fed corn silage and a protein supplement to gain about 1.0 pound daily from November 17 until April 6 (140 days).

Steers were then placed on improved pasture consisting of Russian wild ryegrass (*Psathyrostachys juncea*) and alfalfa (*Medicago sativa*) from April 6 to May 31. They had access to blocks containing poloxalene during this period and were implanted with 24 mg estradiol on May 4. Steers then grazed on native range until August 2. The primary plant species were western wheatgrass (*Pascopyron smithii*), blue grama (*Bouteloua gracilis*), buffalograss (*Buchloe dactyloides*, needleandthread grass (*Stipa comata*), green needlegrass (*Stipa viridula*) and threadleaf sedge (*Carex filifolia*).

On August 2, steers were randomized into three finishing treatments. Group I was placed in drylot and fed a high roughage (HR) diet (Table 1) consisting of 42% corn silage and 58% concentrates on a dry matter basis. Group II was placed in drylot and fed a high concentrate (HC) diet consisting of 20% corn silage and 80% concentrate on a dry matter basis. Group III was placed on semi-irrigated pastureland (P) where the principle grasses were wheatgrasses (*Agropyron spp.*), bromes (*Bromus spp.*), saltgrass (*Distichlis stricta*) and bluegrasses (*Poa spp.*) and were fed the same amount of barley grain as the HC group.

TABLE 1. COMPOSITION AND CHEMICAL ANALYSES OF FINISHING DIETS

	Diet designation					
	HR		HC		P[a]	
Dry matter in diet: Roughage Concentrate	As fed (%)	Dry matter (%)	As fed (%)	Dry matter (%)	As fed (%)	Dry matter (%)
Corn silage	67.44	42.10	41.68	20.54	--	--
Barley	28.91	51.46	52.98	73.33	0.71	0.75
Pellet total[b]	3.64	6.44	4.47	6.13	9.29	9.25
Chemical composition, Dry Matter Basis						
Dry matter	48.75		65.61			
Ash	3.95		3.29			
Crude protein	12.95		13.48			

[a] Does not include dry matter obtained from pasture.

[b] Two pounds of pellets were fed per head daily throughout the study; therefore, percent pellet of the entire diet will vary slightly. Values shown represent an average for final 56 days on feed. Pellet contained barley, soybean meal, molasses, urea, vitamin A, trace minerals and Rumensin.

Two pounds of pellets containing 32% protein, minerals, vitamin A and 180 mg monensin were fed per head to all three groups of steers. Ground barley made up the rest of the concentrate portion of the diet. All steers were started on free choice forage (pasture or corn silage), 4 pounds of ground barley and 2 pounds of protein supplement per head per day. During an adaptation period (18 days for the HR steers and 26 days for HC steers), the barley portion was gradually increased each day until steers received the planned levels of concentrate. Feeding was ad libitum once daily in the morning. All steer weights, initial, interim and final, were taken before the morning feeding. The trial was to end when 60% of the steers in the HC group visually graded U.S. Choice. Steers were on feed for a total of 91 days.

Results and Discussion

Postweaning and Pasture Performance

Steers gained an average of 1.1 pounds daily for the 140-day period and consumed an average of 10.9 pounds of dry matter per day of the corn silage-protein supplement feed. Steers may have gained at a more rapid rate particularly near the end of the study except the amount of feed offered was limited to about 33 pounds per head daily.

While on Russian wild rye-alfalfa pasture from April 6 through May 31 (55 days), steers gained an average of 164 pounds or 2.98 pounds/head/day. These gains demonstrate the potential gaining ability of steers on high quality, improved pastures from sires selected for growth rate.

From May 31 to August 2 for 63 days, steers gained 153 pounds or 2.43 pounds/head daily. Thus, gains of the steers in the present study for the entire 118-day grazing period averaged 2.68 pounds per day, which is similar to the gains of crossbred steers on pasture (2.65 pounds daily) in a study reported previously in the 1984 Station Field Day Report. On August 2, steers averaged 1016 pounds which is much heavier than steers commonly entering the feedlot.

Results of the Finishing Phase

Average daily dry matter intake by the steers in the finishing phase is shown by treatment in Table 2. The average dry matter consumption of steers on the HR diet for the 91-day period was 26.9 pounds per day, which is similar to the 26.7 pounds for the steers fed the HC diet. Concentrate intake of the HC steers (22.1 pounds/day) and concentrate intake of P steers (21.8 pounds/day) were also similar (Table 3).

The difference in gain for the 91 days for steers fed HR (3.74 pounds/day) and the HC diet (3.92 pounds/day) was not significant. Steers fed on pasture gained only 2.80 pounds daily for the 91-day period, which was lower than the other two feed groups. At the end of the 91-day feeding period, steers in the HR, HC and P groups averaged 1357, 1372 and 1272 pounds, respectively.

Carcass weights of the three groups of steers were HR diet, 785 pounds; HC diet, 791 pounds; and P diet, 735 pounds. Some of the steers approached the 900-pound weight, which is near the upper weight limit preferred by packers. No significant differences were found in dressing percent of steers on the three treatments. The percent of steers grading U.S. Choice was 33, 41 and 6% for HR, HC and P groups, respectively. All other steers graded U.S. Good.

TABLE 2. SUMMARY OF PERFORMANCE OF YEARLING STEERS PLACED ON FEED FOR 91 DAYS.

Dry matter in diet	HR	HC	P
Roughage, %	42	20	
Concentrate, %	58	80	
Place	Drylot	Drylot	Pasture
Number of head	18	17	17
Initial weight, pounds	1017	1015	1017
Feed offered daily for 91 days, pounds			
Concentrate portion	16.7	22.1	21.8
Total amount	55.2	44.6	
Dry matter (pasture not included)	26.9	26.7	19.4
Total concentrate offered, 91 days, pounds	1523	2011	1980
Total feed offered (pasture not included), pounds	5023	4056	--

Carcasses of steers fed the HR diet and the HC diet and the P diet averaged 0.54 and 0.49 and 0.39 inches of fat over the loin, respectively. Many of the steers failed to grade U.S. Choice because of lack of marbling. The yield grade of all steers in all groups were either U.S. 2 or 3.

The P steers differed (P<0.01) from the RC and HC groups in fat thickness over the loin, percent kidney and pelvic fat, carcass grade, yield and cutability estimate. They did not differ from the average of the other two lots in rib eye area. The HR and HC groups did not differ from each other in any of the growth or carcass traits studied (P>0.10).

Relationship to weight and growth. The larger steers, which were larger as calves at weaning, gained the most weight during the summer and feedlot periods and maintained the same relative weight position from the beginning to the end of the study.

Economic values. Based on prices received by producers for steer calves 1982-1985,[1] for steers 1983-1986[1] at a Montana Auction and for fed steers 1983-1986, Table 4 was constructed. No attempt has been made to estimate

[1] Prices supplied by Montana Agricultural Experiment Station agricultural economists.

costs of production. If range grass is plentiful, however, and can be produced economically, grazing steers in the spring and early summer would be a good method to increase income. The table shows steers increased an average of $1.80 per day while on the cow, $0.69 per day during the winter, $1.03 per day during the grazing period, and those in drylot increased an average of $1.65 per day on the finishing period.

TABLE 3. GROWTH RATE AND CARCASS CHARACTERISTICS OF STEERS BY DIET AND LOCATION

Diet designation	HR	HC	P
Average daily gain in feedlot, pounds			
1st 28 days	4.27	3.89	1.66
2nd 28 days	3.55	3.97	3.69
Final 35 days	3.46	3.90	2.99
Entire 91 days	3.74	3.92	2.80
Final weight, pounds	1357	1372	1272
Carcass weight, pounds	785	791	735
Dressing %	57.82	57.62	57.79
Fat thickness, loin, eye, inches	0.54	0.49	0.39
Rib eye area, square inches	12.2	12.8	12.6
Kidney and pelvic fat, %	0.86	0.82	0.65
Carcass grade score[a]	10.9	11.2	10.1
Choice, %	33	41	6
Good or Good Plus, %	67	59	88
Good Minus, %	0	0	6
Yield grade	3.0	2.7	2.3
Cutability estimate	49.2	50.0	51.1

[a] Good = 10, Good Plus = 11, Choice Minus = 12, Choice = 13.

TABLE 4. INCREASE IN VALUE PER DAY FOR STEERS FINISHED IN DRYLOT FROM BIRTH TO SLAUGHTER.

Time	Days	Gain in value per day $
Birth to weaning	178	1.80
Winter period	175	0.69
Grazing period	118	1.03
Finishing period	91	1.65

Summary

Steers from sires selected for growth rate gained rapidly at all stages, were larger steers at weaning, and also gained and weighed the most when slaughtered. There is considerable latitude in the ratio of concentrates to roughage that can be fed in finishing diets and still obtain satisfactory feedlot gains for a short feeding period. Steers fed concentrates on pasture did not make as rapid gains as steers fed a complete diet in drylot.

Utilization of summer pasture was a good system to obtain greater weight and economical gains on steers. As the industry and consumer moves to the acceptance of leaner beef, various methods of growing and finishing beef utilizing pasture grasses and a shortened finishing period can be used by the beef cattle producer.

REPRODUCTIVE TRAITS AND GROWTH TRAITS OF TWO-BREED AND THREE-BREED CROSS BEEF CATTLE

W. L. Reynolds, J. J. Urick and R. A. Bellows

Introduction

A beef cattle genetics project at the Station is testing the effectiveness for combining breeds of beef cattle to determine if the composite developed is adapted to the range environment. This is being accomplished by mating Charolais (C) and Tarentaise (T) sires to Red Angus (RA) females. The RA were chosen as the female component to provide highly fertile, medium sized cows with a medium level of milk production and to produce calves with low to medium birth weights that could be finished in the feedlot at 1,000-1,200 pounds. Half of the RA cows were mated by artificial insemination (A.I.) to C sires and the other half to T sires.

The Charolais (C) breed was used to contribute medium to rapid calf growth rate and increase the lean tissue component of the carcass. Charolais bulls were polled and came from established American breeders. Sires were selected within breed from information available from breed associations and from artificial insemination companies and individuals. If available, the information used was calf birth weight, calving ease scores, pre- and post-weaning growth rate and mature bull size.

The Tarentaise (T) breed was used to contribute a medium birth weight to the calves, udder shape and teat placement, medium pre- and post-weaning growth rate and medium size of mature cows. Most of the Tarentaise semen came from private individuals. Sires known to sire large birth weight calves of either breed were not used in the study. Therefore, data derived from the study is not intended to represent breed comparisons by offspring for sires within a breed for the various traits used.

Breeding System

In the formative stage (Phase I), T and C sires were mated to RA dams. In the next phase (Phase II), the CRA males were mated to the TRA females and the TRA males to the CRA females to produce 25% C, 25% T and 50% RA offspring. These 25% C, 25% T and 50% RA were then mated together in the present Phase III program. A 45-day breeding season was used in all phases of the study. Matings in Phase II and Phase III are still in progress. The three-breed crosses are offspring of the two-breed crosses and therefore are younger.

Replacement sires are selected for rapid growth to 12 months except that heavy birth weight individuals weighing 95 pounds or over are not retained for breeding. Yearling heifers are used as replacements. Heifers and cows that are open after the 45-day breeding season are culled.

Results

The purpose of this report is to present data on reproduction and growth rate of Phase II of the study and Phase III where three-breed cross males (25% C, 25% T and 50% RA) are mated to females of the same genetic composition. Reproductive traits where the crossbred males were mated to the crossbred females showed that pregnancy rate of the TRA yearlings was slightly higher (93%) than that of the CRA yearlings (85%) (Table 1). Pregnancy rates of the three-breed cross to the three-breed cross was 85%. The percent of cows experiencing difficulty at calving was slightly higher for calves born to TRA dams than calves born to CRA dams. Calving difficulty has been very low, 1.5 and 1.4%, respectively, for the CRA and TRA dams that are 3 years of age or older. Also, calf death losses are low (2.8%) for calves from TRA dams. Pregnancy rates of 92% and over for 3-year-old and older cows would indicate these cows are all very fertile.

TABLE 1. REPRODUCTIVE PERFORMANCE OF CROSSBRED FEMALES MATED TO CROSSBRED BULLS (1981-1986).

Breed of sire Breed of dam	Phase II Tarentaise-R Angus Charolais-R Angus	Phase II Charolais-R Angus Tarentaise-R Angus	Phase III 3-breed cross 3-breed cross
Yearling heifers			
Number	167	151	241
% pregnant	85	93	85
2-year-old			
Calv. difficulty, %[1]	29	36	23
Calf death loss, %	5.8	4.4	7.0
% pregnant	87	86	88
3-year old or older			
Calv. difficulty, %	1.5	1.4	—
Calf death loss, %	6.9	2.8	—
Pregnancy rate, %	92	95	94

[1] Calving difficulty scores were: 1=unassisted, 2=easy pull, 3=hard pull, 4=cesarean section, 5=abnormal presentation.

Comparison of the birth weights and weaning weights of all calves and the post-weaning gains of male calves from the crossbred sires and crossbred dams for 2 years are shown in Table 2. Calves from the TRA dams have consistently had a slightly higher growth rate and heavier 200-day weight. This, however, can be due to the specific mating cross, CRA mated to TRA rather than to the effect of breed of dam.

TABLE 2. WEANING AND POSTWEANING PERFORMANCE OF CALVES FROM CROSSBRED SIRES AND CROSSBRED DAMS (1985 AND 1986; 2 YEARS).

Breed of sire Breed of dam	Tarentaise-R Angus Charolais-R Angus	Charolais-R Angus Tarentaise-R Angus	3-breed cross 3-breed cross
Birth weight, lb.	82	86	81
Actual ADG, lb.	1.98	2.04	1.86
200-day weight[a], lb.	502	518	536
Postweaning growth rate (1 year)			
Males			
ADG, 168 days, lb.	3.19	3.29	3.24
Final weight, lb.	1018	1036	1027

[a] Adjusted by age of dam and sex to female base.

Post-weaning growth rates of all calves have been near 3.2 pounds daily. All bulls are fed a high roughage ration (54% dry matter) and finished on roughage. Performance of calves from three-breed cross cows was similar to the performance of calves from two-breed cross cows.

Some differences do exist in the pregnancy rates of yearling F_1 dams, with the TRA females having a higher pregnancy rate than the CRA females. When both crossbreds are bred to crossbred sires, no difference was found in pregnancy rates of 2-year-old and older cows. Calf death losses were low in this study, and few cows required assistance. Pregnancy rates in a 45-day breeding period of 3-year-old and older cows were 92% or higher. Weaning weights of calves were slightly over 500 pounds for all breed groups, with calves from TRA dams being slightly higher in pre- and post-weaning growth rates than in calves from CRA dams. Three-breed cross calves which were from younger cows were generally intermediate between the two-breed cross groups.

EFFECTS OF VARIOUS FACTORS ON ABORTIONS CAUSED BY PINE NEEDLES

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Introduction

In the last year, ranchers have reported pine needle induced abortions starting as early as late fall and continuing through the winter. Apparently abortions caused by pine needles are just as big a problem as ever. At our last field day, we reviewed the status of this problem so this report will mainly be an update on our research in this area since then. Several experiments have been conducted in an attempt to better understand and solve the problem of pine needle induced abortions.

Experimental Procedures

Experiment 1. This study was conducted to compare the abortion response of pine needles collected in winter to those collected in summer when fed to cows at eight months of pregnancy. Pine needles were also fed to open cows to determine if physiological changes occur in nonpregnant as well as pregnant cows. The experiment is summarized in Table 1.

TABLE 1. SUMMARY OF TREATMENTS AND RESULTS FOR EXPERIMENT 1.

Animal status	Season PN collected	Diet (lb)		No. cows	No. aborted	Interval to (d)	
		PN	hay			Abort	Calving
Pregnant	Winter	6	6	5	5	9	---
Pregnant	Summer	6	6	5	5	11	---
Pregnant	---	---	12	5	0	---	30
Pregnant	Winter, 1 day feed	6	6	4	1	3	30
Open	Winter	6	6	5			
Open	---	---	12	5			

Fresh needles were collected from the John Day, Oregon area. The needles were dried and then stored until being ground in a hammer mill before feeding. Pregnant cows were fed needles starting at 8 months of pregnancy and continued until abortion or calving occurred. The group of cows which were given pine needles only once had their dose of needles administered in a slurry pumped directly into the rumen. Open cows were fed needles starting on day 8 of a synchronized estrous cycle and continued until the next estrus.

Winter and summer needles were equally effective in causing abortions and a single exposure of winter needles caused one of four cows to abort. There was no effect of pine needle feeding observed on the open cows -- cycle lengths and progesterone profiles were similar between pine needle-fed and control cows.

Experiment 2. Most abortions caused by pine needles are observed during the winter. We don't know whether pine needles will cause cows to abort at other stages of pregnancy or whether this time of year is the only time when cows eat pine needles. This experiment was done to determine what effect varying stage of pregnancy would have on the abortion response to feeding pine needles. Cows were bred at a synchronized estrus at one of four different times of the year so that four stages of pregnancy would be represented on a given date in the fall of 1985. A summary of this experiment is shown in Table 2.

TABLE 2. SUMMARY OF STAGE OF PREGNANCY EFFECTS IN EXPERIMENT 2.

Average stage of pregnancy (d)	No. cows	% aborted	Days to abort
254	7	100	5.3
215	6	50	8.0
167	8	38	21
116	7	0	--

Pine needles collected from Custer County, Montana were handled as in Experiment 1. Cows were group fed a diet of 6 pounds ground, dried needles and 6 pounds ground hay until abortion occurred or for 3 weeks. As stage of pregnancy decreased, the response to pine needles decreased. A response decrease was evident by a decrease in the percent that responded and by an increase in the interval to abortion.

Experiment 3A. In the past, our research with pine needles has used a level of feeding that was determined by how much a cow will consume. Most cows will eat about 6 pounds per day of dried needles if they are hungry and the needles are mixed with an equal amount of hay. The effects of smaller amounts of pine needles are not known. Also little is known about the length of exposure required to cause abortions. Therefore, the objective in this experiment was to explore the effects that varying both amount and length of feeding pine needles have on induced abortions. A secondary objective was to determine whether injections of vitamin A would prevent pine needle induced abortions. Cows were assigned at random to one of the treatments summarized in Table 3.

TABLE 3. EFFECTS OF VITAMIN A AND LENGTH AND AMOUNT FED ON PINE NEEDLE (PN) ABORTION.

Treatment designation	No. cows	Amount Fed (lb.)		No. d fed PN	% aborted	Interval (d) to calving
		PN	hay			
Control	14	0	12	0	0	33
1.5 PN	10	1.5	10.5	21	80	19
3 PN	10	3	9	21	90	17
6 PN	10	6	6	21	100	10
PN-3	10	6	6	3	30	26
PN-1	9	6	6	1	10	34
VA+PN[a]	6	6	6	14	83	11

[a] This group was injected with 4.5 million i.u. of vitamin A before PN feeding started.

Pine needle feeding started on about 250 days of pregnancy and continued until abortion occurred or until the specified number of pine needle feeding days was reached. Feeding the lower amounts of pine needles still caused most cows to abort, but the interval to abortion increased as the amount fed decreased. Decreasing the number of days needles were fed drastically reduced the abortion response although some response was still observed since 30% aborted after 3 and 10% after 1 day of feeding. Vitamin A did not prevent abortions.

Experiment 3B. This experiment was run concurrently with 3A and was conducted to determine if pine needles would cause abortions in other ruminants. Pregnant sheep and goats were fed pine needles from the same batch as that fed to cows in Experiment 3A. Sheep were fed either 1.5 pounds of hay and 1.5 pounds of pine needles (treated) or 3 pounds of hay (control), and goats were fed either 1 pound hay + 1 pound pine needles (treated) or 2 pounds hay (control). No effects were observed in either goats or sheep as a result of the pine needle feeding.

Experiment 4. The site of action of the pine needle agent is not known. The corpus luteum (CL) and placenta both produce progesterone during late pregnancy, thereby both then contribute to the maintenance of that pregnancy. We attempted to pinpoint whether the pine needle agent is affecting the corpus luteum or the placenta in this experiment. One-half of the cows were injected with $PGF_2\alpha$ (Lutalyse®) on days 236 and 237 of pregnancy to cause regression of the CL. Then half of each of these groups were fed pine needles (4.5 pounds/day starting on day 250 of pregnancy. This experiment is summarized in Table 4.

TABLE 4. EFFECTS OF REGRESSING THE CORPUS LUTEUM ON ABORTION RESPONSE OF COWS FED PINE NEEDLES.

Treatment	PN fed	No. cows	Interval to calving (d)
Control	No	8	37
Control	Yes	8	11
CL regressed	No	8	19
CL regressed	Yes	8	14

Pine needles caused abortions just about the same regardless of whether or not the CL was present so apparently the site of action does not directly involve the CL. This conclusion is also supported by the results of Experiment 1.

Experiment 5. This is the last study in this sequence that has been conducted although hormone assays are not completed. In the previous experiments, blood samples were taken during the pine needle feeding period to explore some of the mechanisms that are involved in the resulting abortions. We have not presented these data because they are not all complete and in some cases somewhat confusing or conflicting. Our data in the last field day report showed that there was a marked and consistent rise in progesterone (P_4) associated with pine needle feeding which dropped before abortion occurred (although it was still higher than controls at the time of parturition). Changes were also observed in estrogen and cortisol but those changes were more associated with parturition rather than pine needle feeding. Preliminary summaries of hormone changes in subsequent experiments have shown these hormone changes are not consistent and may in some way be related to external stresses (either independently or in combination with pine needle feeding). This last experiment was conducted in an attempt to sort out this puzzle. The first objective was to test whether the stress of daily tail bleeding affects the abortion response to pine needle feeding. A second objective was to determine if pine needles can be pelleted and still maintain their abortifacient effects. Three bleeding stress treatments were used: none, tail bleeding started 20 days before pine needle feeding or tail bleeding started 2 days before pine needle feeding. This experiment is summarized in Table 5.

TABLE 5. EFFECT OF BLEEDING STRESS AND PELLETING OF PINE NEEDLES (PN) ON PINE NEEDLE INDUCED ABORTION.

Bleeding stress	PN fed	No. cows	Interval (d) to parturition
None	No	8	30
	Yes	8	5.5
20 d before	No	7	34
	Yes	7	7.9
2 d before	No	8	29
	Yes	8	15
None	Pelleted	8	15

Tail bleeding stress had a marked effect on the interval to abortion in the pine needle fed cows. Cows that were not tail bled or run through a chute very consistently aborted in a short time (5.5 days). When cows were run through a chute daily and tail bled starting only 2 days before pine needle feeding, that interval was delayed to 15 days and it was highly variable (range, 5-23 days). This stress effect was prevented by giving the cow a 3-week adjustment period before feeding started (7.9 days).

Cows fed pelleted needles also aborted (15 days) but the response was much delayed from that of cows fed needles from the same batch but not pelleted (5.5 days).

Discussion and Conclusions

The results from these experiments provide us with useful clues in unravelling the pine needle abortion puzzle. Unfortunately, we have not progressed to the point of being able to prevent these abortions (other than making sure cows don't have access to needles). On the bright side though, these clues are helpful enough that we are encouraged to forge ahead and will come back with better recommendations in the future.

Our conclusions from these studies are:

1. Both winter and summer collected needles cause abortion.

2. Adverse effects are observed in pregnant but not open cows. Apparently the effects of the pine needle agent are on the utero-fetal unit rather than the ovary.

3. Pine needles have their greatest effect during late (8 months) pregnancy although some effects can be seen as early as 5 months. This agrees with reports from producers last fall where cows aborted in pine trees in November-December.

4. Some effects of pine needles are observed when needles are fed for only 1 or 3 days and at amounts as low as 1.5 pounds/day, but the greatest response was seen when needles were fed longer and at higher levels (6 pounds/day).

5. No evidence was found that vitamin A will prevent the abortions caused by pine needles.

6. The presence or absence of a CL does not affect the response so this is further evidence that the site of action is the utero-fetal unit rather than the ovary.

7. Stress in addition to the pine needle feeding can delay but not prevent the response. Future research will need to take this complication into account.

8. Pelleting partially destroys or removes the abortifacient effects of pine needles.

9. Sheep and goats did not abort when fed pine needles. Unfortunately, they cannot be used as a "laboratory model".

10. Pine needles collected in Custer County, Montana are just as much a problem as those collected in Utah or Oregon.

A SELECTION EXPERIMENT TO CONTROL BIRTH WEIGHT IN CATTLE

J. J. Urick, W. L. Reynolds and R. A. Bellows

Birth weight has been identified as the single most important factor affecting difficult calving problems. Estimates of genetic correlations of birth weight with subsequent weights in Hereford cattle at Miles City ranged from 0.5 to 0.6 indicating that there should be some latitude for control of birth weight while continuing to increase subsequent growth to yearling weight. This selection study was initiated in 1977 to study the effect of restricting birth weight of bulls selected for herd sires on subsequent progeny growth and reproduction traits.

To initiate the experiment, about 160 females of the Line 1 herd were randomly divided into 2 subherds designated as Y and YB. Bull calves were fed 168 days in the feedlot after a 14-day adjustment period following weaning. The diet consisted of primarily corn silage with oats, corn, soybean oil meal supplement added. The heifers were fed 140 days in small areas following a 28-day adjustment after weaning. The heifers' ration consisted of primarily corn silage and soybean as supplement.

In the Y herd, sire replacements are selected for high yearling weight which is measured at 365 days. No restriction is placed on birth weight in Y. The subherd YB sire replacements are selected for the same criteria but with the restriction that birth weights are average or below average of the Line 1 herd. All herd sire replacements are given a breeding soundness examination at approximately 13 months of age.

The heifer selection is at 18 months of age off grass. Selection criteria for heifers are similar as for bulls except in YB there has been very little restriction on heavy birth weight. On the average, 75% of the heifers in each subherd are retained for replacements. Heifers not pregnant in a normal breeding season (60 days) and those with a low yearling weight are culled. Cows are culled if they become physically unsound and if they fail to conceive in a normal breeding season. With a few exceptions, cows are replaced at 10 years of age.

For this report, data were from sires used in the breeding seasons of 1977-1985, and their progeny produced in years 1978-1986 within each of the Y and YB herds. Yearling weight data are from 1979-1985.

Results

The average performance data for the Y and YB sires used to produce calves in years 1978-1986 are shown in Table 1, and the corresponding preweaning and postweaning performance of their calf progeny is shown in Tables 2 and 3.

TABLE 1. AVERAGE PERFORMANCE OF SIRES SELECTED FOR Y AND YB HERDS (CALF YEARS, 1978-1986)

Herd	No.[1] sires tested	Average[2] birth weight (lb)	Average[2] 205-day weaning weight (lb)	Average daily gain on feedlot test (lb)	365-day[2] yearling weight (lb)
Y	21	92.5	556	3.17	1037
YB	21	79.8	543	3.10	1007
Y minus YB sires (lb)		12.7	13.0	0.07	30.0
% difference		13.7%	2.4%	2.2%	2.8%

[1] Sires were repeated for 2 consecutive years.
[2] Adjusted to the 5 to 9 year mature age group.

The records shown in Table 1 are for 21 individual sires in each of the Y and YB herds. Most of these bulls were used for 2 consecutive years starting at either 1 or 2 years of age. The average differences of Y and YB sires for growth traits are shown in Table 1. These differences resulted because of the restrictions placed on heavy birth weight. The YB sires in comparison to the Y sires had smaller birth weights of 12.7 pounds (13.7%), weaning weights of 13.3 pounds (2.4%), postweaning feedlot ADG gain of 0.07 pounds (2.2%) and yearling weights of 29.7 pounds (2.8%). These Y and YB sire performance comparisons show that the intense negative selection pressure for birth weight in YB sires still allowed for selection of sires with a slightly reduced but acceptable preweaning and postweaning growth.

TABLE 2. BIRTH AND WEANING WEIGHTS OF CALVES IN Y AND YB HERDS, 1978-1986.

				Bulls and heifers combined					
				Birth weight (lb)[1]			180-day weight (lb)[2]		
Age of dam	Generation of Calf[3]	No. obs. Y	No. obs. YB	Lbs Y	Lbs YB	Y-YB Difference	Lbs Y	Lbs YB	Y-YB Difference
2 yr.	g1	28	31	72.3	65.7	6.6	418	425	-7
	g2	42	23	74.2	70.1	4.1	451	431	20
	g3	27	23	76.9	72.1	4.8	458	416	42
3 yr.	g1	39	24	79.5	73.0	6.5	430	408	22
	g2	24	27	83.6	79.8	3.8	464	435	29
4 yr.	g1	28	37	76.0	79.5	-2.5	427	420	7
	g2	24	29	85.0	81.4	3.6	479	470	9
5 yr. +	g1	84	77	81.6	82.4	-.8	431	438	-8
	g2	50	50	82.8	82.4	.4	459	451	8

[1] Actual birth weight of calf--no adjustment for age of dam.
[2] Adjusted for age of dam to the 5-9 age mature group.
[3] The original dams and sires used were designated as generation 0. The generation of calf is calculated as follows: (sire generation + dam generation) ÷ 2 + 1.

TABLE 3. WEIGHTS (365-DAY) OF BULLS AND HEIFERS IN Y AND YB HERD, 1979-1985.

		365-day weight[1] bulls (lbs)			365-day weight[1] heifers (lbs)		
Age of Dam	Generation[2] of Calf	Lbs Y	Lbs YB	Y-YB Difference	Lbs Y	Lbs YB	Y-YB Difference
2 yr.	g1	927	936	-9	700	699	1
	g2	980	953	27	729	699	30
	g3	951	871	80	713	674	39
3 yr.	g1	1,003	994	9	693	660	33
	g2	1,009	965	44	740	725	15
4 yr. +	g1	980	994	14	690	680	10
	g2	991	991	0	739	727	12

[1] Adjusted for age of dam to 5-9 age mature group.
[2] See footnote (3) under Table 2 for explanation of generation.

Discussion of Results

The changes in growth of progeny of the Y and YB sires over several generations and the differences among the two herds within ages of dams are shown in Tables 2 and 3. In these preliminary comparisons, there was a partial confounding of years with generation, which could have reduced the accuracy of the overall estimates of growth responses presented. However, the trends of the generation responses to selection among the Y and YB herds within ages of dams were generally consistent and allowed for some meaningful conclusions to be drawn.

For pre-weaning traits of the calves (bulls and heifers combined) from 2-, 3- and 4-year-old dams, there were trends of increases in birth weight and weaning weight in the later generations in both Y and YB herds. The YB calves from 2-year-old heifers averaged over three generations, had 5.1 pounds smaller birth weights and 18 pounds lighter weaning weights than Y calves. In the 2-year-old heifers, the weaning weight differences of Y-YB increased from -7 pounds in generation 1 to 42 pounds in generation 3 in favor of Y calves. The trends of differences between the Y and YB calves from the 3- and 4-year dams over generations were similar to trends of the differences between Y and YB calves of the 2-year-old dams. The average birth and weaning weights of calves of 5-year and older dams in Y and YB were similar. Part of the 5+ year-old dams were the original dams which were similar in Y and YB.

For post-weaning growth of bulls and heifers (Table 3), the main trait included in these comparisons was 365-day yearling weight. The trends of Y-YB differences for 365-day weight of bulls and heifers within ages of dams were similar to those for pre-weaning growth of calves. The results indicate that the 365-day weight advantages in both bulls and heifers were carryover advantages from weaning. The average post-weaning 168-day gains among the Y and YB bulls were similar. Among the Y and YB heifers, the 140-day post-weaning test gains were similar.

Comparisons of Calving Results:

One objective of the study was to evaluate the effect of the reduction of birth weight in calves on calving difficulties. On the average, calves from the 2-year-old heifers in YB had 5.1 pounds smaller birth weights than the Y calves, which resulted in fewer (8%) calves having to be assisted in comparison to Y herd. The percentage of non-assisted births in YB and Y 2-year-old heifers respectively were 52 and 44%. Calves from 3-year-old heifers in YB were 5.2 pounds lighter than from Y, but the percentage of unassisted births were similar (90% in YB vs. 90% in Y). The average calf birth weight of the 4 year and 5+ year aged groups of dams in YB was 81.4 pounds, the same as for the Y cows. The percentage of unassisted births in YB and Y for the older cows was similar (97% in YB vs. 96% in Y). The results showed that selecting for reduced birth weights in the sires was mainly beneficial for reducing calving difficulty in the 2-year-old heifers.

Conclusions

Calf birth weights were reduced through selecting sires with lower birth weight, but the benefit of reducing calving difficulty resulted mainly in the 2-year-old heifers. The lighter birth weights in calves were associated with smaller weaning weights and yearling weights in the 2- and 3-year-old heifers. These results are from a relatively highly inbred herd of Hereford cattle selected for growth.

CALVING DIFFICULTY STUDIES

R. A. Bellows, D. J. Patterson, D. A. Phelps and W. L. Milmine

Introduction

Calf deaths occurring from birth to weaning result in a major reduction in production efficiency of beef herds. Two areas of research are summarized in this report. Area 1 is a survey of calf losses at LARRS over a 15-year period. Area 2 is a study conducted to determine effects of combining induced calving and early obstetrical assistance on calf survival, vigor and growth and subsequent reproduction of the dam.

Area 1

Data from 13,296 calvings collected over a 15-year period indicated 893 calves died from birth to weaning for a 6.7% average loss (Table 1).

TABLE 1. CALVINGS AND CALF LOSSES PER YEAR: 1963-1977[a]

Year	Number females calving	Number calves lost/year**	Annual loss (%)	Total loss (%)[b]
1963	667	50	7.5	5.6
1964	672	44	6.5	4.9
1965	730	59	8.1	6.6
1966	719	48	6.7	5.4
1967	947	46	4.8	5.2
1968	798	28	3.5	3.1
1969	917	58	6.3	6.5
1970	938	58	6.2	6.5
1971	950	44	4.6	4.9
1972	923	46	5.0	5.2
1973	938	52	5.5	5.8
1974	981	91	9.3	10.2
1975	1,110	147	13.2	16.5
1976	976	58	5.9	6.5
1977	1,030	64	6.2	7.2
Total	13,296	893	6.7[c]	100.0

[a] Losses represent deaths occurring from birth to weaning.
[b] Percent of total loss over the 15-year period.
[c] Average calf mortality percentage.
** $P<0.01$.

Calf deaths from first-calf 2- and 3-year-old dams accounted for 41.0% of total mortality. Losses within groups were: first-calf 2-year-olds, 10.9%; first-calf 3-year-olds, 8.7%; second calf 3-year-olds, 4.1%; second-calf 4-year-olds, 8.3%; multiparous 4-year-olds, 4.8%; and dams 5 years and older, 5.3% (Table 2).

TABLE 2. CALVINGS AND CALF DEATHS BY DAM AGE AND PARITY.

Age and parity of dam	Number of dams calving	Calf deaths within dam age and parity group: Number**	Calf deaths within dam age and parity group: Percent	Percent of all deaths
2-yr	2,257	245	10.9	27.4
1st-calf 3-yr	1,394	121	8.7	13.5
2nd-calf 3-yr	1,461	60	8.1	6.7
2nd-calf 4-yr	1,262	105	8.3	1.8
3rd-calf 4-yr	1,032	50	4.8	5.6
5-yr	1,760	76	4.3	8.5
6-yr	1,406	65	4.6	7.3
7-yr	1,050	64	6.1	7.2
8-yr	753	44	5.8	4.9
9-yr	486	30	6.2	3.4
10-yr	298	22	7.4	2.5
11-yr	104	9	8.6	1.0
12-yr	28	2	7.1	0.2
13-yr	5	0	0.0	0.0
Total	13,296	893	--	100.0

** P<0.01.

Calves lost from birth through day 3 postcalving account for a 4.6% loss with an additional 2.1% loss from day 4 through weaning (Table 3).

TABLE 3. CALF LOSSES BY TIME OF DEATH AND CATEGORY OF GREATEST LOSS.

	Calf deaths			Greatest death category			
						Percent of deaths	
Time of death[a]	No.	%**	Cumulative loss (%)	Category	No.	Within day	Of total deaths
0	513	57.4	57.4	Dystocia	357	69.6	40.0
1	48	5.4	62.8	Dystocia	19	39.6	2.1
2	26	2.9	65.7	Dystocia	8	30.8	0.9
3	27	3.0	68.8	Dystocia	9	33.3	1.0
4	18	2.0	70.8	Euthanasia	4	22.2	0.4
5	11	1.2	72.0	Accidental death	6	54.5	0.7
6	13	1.5	73.5	Pneumonia; scours	6	46.2	0.7
7	14	1.6	75.0	Pneumonia; scours	6	42.9	0.7
8	15	1.7	76.7	Pneumonia; scours	4	26.7	0.4
9	13	1.5	78.2	Pneumonia; scours	5	38.5	0.6
10	10	1.1	79.3	Pneumonia; scours	4	40.0	0.4
11-41	87	9.7	89.0	Pneumonia; scours	35	40.2	3.9
42-101	51	5.7	94.7	Missing/unknown[b]	25	49.0	2.8
102-wean	47	5.3	100.0	Missing/unknown[c]	23	48.9	2.6
Total	893	100.0	100.0		511	--	57.2

[a] Day 0 = death occurred within the first 24 hours postcalving; Day 1 = death occurred 24 to 48 hours postcalving, etc.
[b] Of the 25 missing/unknown calves that died during days 42 to 101, 3 were found dead and 22 were missing and not found.
[c] Of the 23 missing/unknown calves that died during days 102 to weaning, 5 were found dead and 18 were missing at weaning and not found.
** $P<0.01$.

The majority of calf deaths (57.4%) occurred within the first 24 hours post-calving with 75% of the total occurring days 0 through 7 and was similar among all dam age and parity groups. Calf death due to dystocia accounted for the single largest loss category through the first 96 hours postcalving, resulting in 69.6, 39.6, 30.8 and 33.3% of the loss incidence for day 0, 1, 2 and 3 postcalving, respectively. More ($P<0.01$) male calves (510; 57.6%) died than females (376; 42.4%).

Backward presentations occurred more frequently (P<0.01) than breech (1.6 vs. 0.6% of all births, respectively). Incidence of backward presentation was 2.3%, 5.6% and 0.9% for first-calf 2-year-old, 3-year-old and multiparous dams, respectively (P<0.01); 64.2% of the backward calves were males and 35.8% females (P<0.01). Survival of calves in backward presentation exceeded (P<0.01) that of breech calves (70.7 vs. 32.9%) (Table 4).

TABLE 4. BACKWARD AND BREECH PRESENTATION DATA SUMMARIZED BY DAM AGE-PARITY AND CALF SEX[a].

Item	Backward				Breech			
	Percent total births in study	Born		Survival (%)	Percent total births in study	Born		Survival (%)
		No.	%			No.	%	
First-calf								
2-yr-old	2.3[b]	52	24.2	59.6	0.5	11	13.9	54.5
Sex: M		34	65.4*	61.8		7	63.6	57.1
F		18	34.6	55.6		4	36.4	50.0
3-yr-old	5.6[c]	78	36.3	80.8	0.6	9	11.4	33.3
Sex: M		49	62.8*	81.6		5	55.6	40.0
F		29	37.2	79.3		4	44.4	25.0
Multiparous	0.9[d]	85	39.5	68.2	0.6	59	74.7	28.8
Sex: M		55	64.7*	70.9		27	45.8	37.0
F		30	35.3	63.3		32	54.2	21.9
Total	1.6[e]	215	100.0	70.7[g]	0.6[f]	79	100.0	32.9[h]
Sex: M		138	64.2*	72.5		39	49.4	41.0
F		77	35.8	67.5		40	50.6	25.0

[a] Data summary based on all calvings in 15-year study, includes both live and dead calves.
[b,c,d] Backward presentation-dam age comparisons, P<0.01.
[e,f] Total incidence of backward vs. breech presentations, P<0.01.
[g,h] Survival of backward vs. breech presentation, P<0.01.
* P<0.05, male vs. female.
** P<0.01, male vs. female.

Fall pregnancy rate of dams that lost calves and reentered the breeding herd that same year was 72.4% compared to 79.4% ($P<0.01$) for contemporary females that did not lose calves (Table 5).

TABLE 5. SUBSEQUENT PREGNANCY RATES OF COWS LOSING CALVES.

Age and parity of dam	Number females exposed for breeding	Pregnancy rate year following calf loss: Number pregnant	%[a]
2-yr-olds losing calves	196	137	69.9
Contemporary 2-yr-olds[b]	2,053	1,536	74.8
1st calf 3-yr-olds losing calves	112	87	77.7
Comtemporary 3-yr-olds[b]	1,377	1,081	78.5
Multiparous dams losing calves	414	299	72.2[c]
Contemporary multiparous dams[b]	9,481	7,630	80.5[d]
Total losing calves[e]	722	523	72.4[c]
Contemporary total	12,911	10,247	79.4[d]

[a] Row percentages.
[b] Contemporary dams were within same year and age grouping but calved without calf loss.
[c,d] Percentages with different superscripts differ ($P<0.01$).
[e] Represents total number retained for breeding; see text for explanation of additional 171 head.

The depression in pregnancy rate was not specifically due to dystocia but apparently to some general effect of calf loss.

Autopsies were completed on 798 calves lost from birth to weaning over the 15-year period. Autopsies determined cause of death and anatomical normalcy of the skeletal, muscle and organ systems and lung functional status. Of the 798 calves, 78% were anatomically normal and 22% abnormal ($P<0.01$) and 75% of the total deaths of abnormal calves occurred by day 2 postcalving. Internal hydrocephalus was identified and confirmed heritable as a lethal recessive. The number of calves lost from dystocia (406 calves; 51%) exceeded losses from all other causes (392 calves; 49%). Lung status was determined for 492 calves dying at birth with 40% and 60% having functional and nonfunctional lungs, respectively ($P<0.01$, Table 6).

TABLE 6. SUMMARY OF NECROPSY FINDINGS.

	Number	%
Total calves lost (15 years)	893	100
Calves autospied	798	89
Time of death		
Day 0	492	62[a]
Days 1-10	187	23[a,b]
Days 11-41	72	9[b]
Days 42-101	25	3[b]
Days 102-weaning	22	3[b]
Anatomical status		
Normal	620	78[c]
Abnormal	178	22[d]
Calf sex		
Male	458	57[c]
Female	340	43[d]
Major cause of loss		
Dystocia	406	51
Nondystocia	392	49
Lung status (calves lost at birth)		
Functional	195	40[c]
Nonfunctional	297	60[d]

[a,b] Different superscripts indicate differences, ($P<0.05$).
[c,d] Different superscripts indicate differences, ($P<0.01$).

Diseases, mainly scours and pneumonia, ranked second in importance as cause of death (13%) followed by exposure-chilling (6%) due to cold and wet conditions. Abnormalities observed included heart anomalies (24 calves), hydrocephalus (38 calves) and a missing segment of the hind gut (8 calves). Multiple abnormalities were found in 15 calves with finding similar to those resulting from maternal consumption of toxins from poison hemlock (Conium maculatum) during gestation. Twelve calves died from peritonitis resulting from a perforated abomasal ulcer caused by accumulated hair.

Of the 373 dystocia deaths in anatomically normal calves, 121 (32%) involved abnormal presentation with calves involved in backward or breech presentation accounting for 62% of the losses from abnormal presentation. Calves experiencing hiplock or retained front leg(s) were heavier ($P<0.05$) than calves presented in normal, backward or breech positions. Dystocia scores were assigned to 253 calves dying at parturition. Percentage losses within score were 53, 7, 32 and 10 ($P<0.05$; Table 7). Birth weights were 75, 80, 86 and 82 pounds ($P<0.05$) for scores of 1, 2, 3 and 4, respectively.

TABLE 7. DATA FROM ANATOMICALLY NORMAL CALVES LOST FROM DYSTOCIA.

	Number	%
Total	373	100
Presentation at birth		
Normal	252	68[a]
Backward	38	10[b]
Breech	37	10[b]
Hiplock	16	4[b]
Retained front leg	20	5[b]
Retained head	4	1[b]
Other	6	2[b]
Dystocia score		
1	133	53[c]
2	17	7[c]
3	78	32[c,d]
4	25	10[d]

[a,b] Means with different superscripts differ, $P<0.01$.
[c,d] Means with different superscripts differ, $P<0.05$.
[e] Dystocia scores not given first 2 years of the study; scores shown for normal presentations only.

We conclude from this work that calf loss reduces production efficiency through both calf deaths and lower subsequent pregnancy rates of dams that lost calves. The magnitude of these losses could be reduced through improved management. This improved management would be close observation of the pregnant dam near calving and identifying and correcting dystocia problems. Incidence of calf abnormalities could be reduced by control of poisonous (teratogenic) plants and use of herd sires free from genetic defects.

Area 2

Crossbred beef females (33 second-calf cows and 73 first-calf heifers) that had been bred to a single Hereford sire were assigned to a study involving age of dam, natural or induced calving and late emergency or forced early obstetrical assistance. Calving was induced with a 10-mg injection of flumethazone given between 2:00 PM and 4:00 PM on day 272 of gestation. Early assistance was given when the cervix and birth canal were fully dilated. Average induced calving occurred 39.6 hours postinjection and 95.3% of the treated dams responded (within 60 hours postinjection). Dystocia score (from

1=no assist to 4=major traction required and 5=abnormal presentation) was 1.12 vs. 2.40 for late and early assistance, respectively (P<0.01), and 11% of late assistance dams vs. 84% of early assistance dams were assisted (P<0.01, Table 8). Calf vigor score (1=normal to 3=depressed or dying) at birth was improved by induction (1.3 vs. 1.1, P≈0.06) and depressed by early assistance (1.1 vs 1.3, P<0.05). This latter effect was due to reduced vigor of calves experiencing abnormal presentation.

TABLE 8. MEANS FOR CALVING DATA.

		Dam data				Calf data		
		Induction						
	No.	Time (h)	Response (%)	Retained placenta (%)	Gestation length (d)	Birth weight (lb)	Calving difficulty score[b]	Vigor[b] score
Dam age								
Heifer	73	39.4	94.7	12.3	275.1	67.9	1.80	1.18
Cow	33	39.9	95.9	9.1	276.0	71.9*	1.73	1.23
Parturition								
Natural	61	--	--	10.0	277.0†	71.7	1.81	1.31†
Induced	45	39.6	95.3	13.0	274.1	69.4	1.72	1.10
Obstetrical assistance								
Late	55	41.9	94.7	10.0	275.8	69.9	1.12	1.08
Early	51	37.4	95.9	11.8	275.3	70.1	2.40**	1.33*
Calf sex								
Male	51	38.4	96.4	7.8	275.2	71.0	1.77	1.26
Female	55	40.9	94.2	14.5	275.9	68.8	1.75	1.15

[a] Means are from induced dams only.
[b] See text for description of scores and discussion of any interactions.
† P<0.10.
* P<0.05.
** P<0.01.

Birth weight and weaning weights of calves from cows exceeded those from heifers, but induction and early assistance had no significant effect on either birth (Table 8) or weaning weight (Table 9).

TABLE 9. MEANS FOR DAM AND CALF WEIGHTS AND GAINS.

		Dam data weight change			Calf data weight gain		
Item	No.	Calving to prebreed[b] (lb/d)	Calving to October (lb/d)	Weaning body wt[c] (lb)	Birth to prebreed[b] (lb/d)	Birth to weaning (lb/d)	Weaning body wt[c] (lb)
Dam age							
Heifer	63	0.22†	0.13**	900	1.59	1.43	345
Cow	30	-0.22	-0.18	999**	2.25**	1.94*	465**
Parturition							
Natural	52	-0.22	-0.22	950	1.94	1.72	407
Induced	41	0.22	-0.22	948	1.90	1.67	402
Obstetrical assistance							
Late	50	0.11	0.22	927	1.81	1.63	387
Early	43	-0.09	-0.04	972	2.03†	1.74	422
Calf sex							
Male	44	-0.09	-0.04	930	1.87	1.67	405
Female	49	0.08	-0.22	968†	1.96	1.70	405

[a] See text for discussion of interactions.
[b] Prebreeding weight = begin breeding season, June 15.
[c] Weaning = October 17.
† P<0.10.
** P<0.01.

Effects of induction and early assistance on postpartum interval, conception rate and fall pregnancy percentage were not significant. Fall pregnancy was improved by 13.3 percentage points ($P<0.10$) in early assisted dams and induction tended ($P \approx 0.08$) to reduce number of breedings per conception (Table 10).

TABLE 10. LEAST-SQUARE MEANS FOR REPRODUCTION TRAITS OF DAM[a].

Item	Number	Postpartum interval (d)	Services per conception[b] (no.)	October pregnancy (%)
Dam age				
Heifer	63	47.3	1.17	81.9
Cow	30	47.6	1.22	91.8
Parturition				
Natural	52	46.9	1.29†	86.5
Induced	41	47.9	1.09	87.2
Obstetrical assistance				
Late	50	48.0	1.24	80.2
Early	43	46.9	1.15	93.5†
Calf sex				
Male	44	50.2	1.17	88.4
Female	49	44.6	1.22	85.2

[a] See text for interaction.
[b] Calculated on pregnant dams only.
† $P<0.10$.

Interaction effects of induction and early assistance on dam reproduction and weight change and calf growth were nonsignificant. We conclude that, when done correctly, induction and early assistance can be combined to predict when calving will occur and to hasten the calving process without detrimental effects on either dam or calf. This combination could be used by cattlemen to schedule and manage intensive calving periods by hastening completion of induced calvings but should not be viewed as a means to improve calf growth or reproductive performance of the dam. The success of this practice would be fully dependent on adequate calving facilities, accurate determination of birth canal dilation, application of correct obstetrical techniques and intensive disease prevention and control measures, including treatment of retained placentas. The lower (13.3%) pregnancy rate noted in dams having prolonged labor agrees with previous Miles City work. The results obtained in both studies are interpreted to mean this effect can be overcome by early obstetrical assistance.

HISTORICAL PERSPECTIVE
FORT KEOGH LIVESTOCK AND RANGE RESEARCH STATION

The Custer Massacre of June 25, 1876 was the spring-board for the establishment of Fort Keogh as an Army cavalry post and led to the founding of Miles City. In 1879, Miles City, Montana was designated the county seat of Custer County and the first court session was held there in May 1879.

Congress established the Fort Keogh Military Reservation, July 22, 1876. Fort Keogh was named after Captain Myles Keogh, an adjutant to General George Custer, killed in the Battle of the Little Big Horn on June 25, 1876. Establishment and early development of Fort Keogh was under the direction of General Nelson A. Miles. Both Fort Keogh and Miles City have remained to serve the vast ranching areas of southeastern Montana and the surrounding Northern Great Plains.

In 1907, all infantry troops were withdrawn and in 1910 Fort Keogh became a Remount Station for the U. S. Army. This Remount Station was very active in World War I. During this period more horses were processed here than at any other army post in the United States. Horses were shipped worldwide. In 1922, the Army relinquished the land and the Fort Keogh military withdrawal was terminated on February 2, 1924.

By an Act of Congress dated April 15, 1924 (43 Stat. 99) jurisdiction of the Fort Keogh Military Reservation was transferred to the U.S. Department of Agriculture for experiments in stock raising and growing of forage crops. On site remains of the original Fort include the parade grounds, two officers quarters built in 1877 and 1879, a wagon shed built in 1883, the flag pole erected in 1887, and seven other structures built prior to 1924.

The size of the original Fort Keogh Military Reservation was 100 square miles or 64,000 acres. The Fort Keogh Livestock and Range Research Station now occupies about 56,500 acres. In 1878, a large piece of land east of the Tongue River was released by the Army and is now the present site of the City of Miles City. Since that time, additional land has been released for the Miles City industrial sites, Custer County fairgrounds, the warm-water fish hatchery and Spotted Eagle Recreation Area. Approximately 1,800 acres are under irrigation in the Yellowstone River Valley west of the Station headquarters. About 625 is in cultivated crops and 1150 in irrigated pastures. The remainder of the Station is rough, broken badlands typical of range cattle producing areas of the Northern Great Plains.

Animal herd size is presently about 2000 head which includes approximately 700 calves. The beef breeding herd is maintained in 30 to 50 animal unit herds. In 1979, there were 3250 head of cattle on the Station and there were 1681 cows bred in 72 separate sire groups. This was the largest cattle inventory in the history of the Station. Decreasing range conditions and severe drought during the 1980's forced reductions from that number. Replacement heifers, young bulls and steers, herd bulls and cattle on reproduction, range nutrition or range forage experiments make up the remainder of the inventory.

A total of 45 permanent employees are involved in Station research studies. Twelve of these positions are with the U. S. Department of Agriculture and include 8 professional scientists, a Location Statistician, Administrative

Officer, Purchasing Agent, Federal Secretary and Maintenance Foreman. Thirty-three positions are with the Montana Agricultural Experiment Station. This includes 4 Professional Research Associates who function in program supervision positions. Twenty-nine are classified personnel with MAES and are employed under two union contracts. An additional 10 to 20 temporary positions are used to support research studies depending on time of year and project needs. These positions are both union, non-union and student employees.

The early Station was a widely diversified unit. There were approximately 1200 Rambouillet ewes on experiment during the early days. Ewes and lambs were on breeding and feeding experiments and wool studies. All sheep were transferred to the U.S. Sheep Experiment Station, Dubois, Idaho, in 1941.

There was also a Milking Shorthorn dairy herd maintained on the Station. The milk was sold to the employees, but the animals were not used extensively for research purposes. The herd was dispersed in the late 1930's.

There have also been many horses on experiments. In 1934, the inventory showed 250 head on breeding, feeding and reproduction studies involving purebred Belgian, Morgan and Thoroughbred sires. Some of the early work to develop successful semen collection and artificial insemination techniques in horses was conducted at this Station. The Thoroughbred breeding herd was maintained until 1964. There are now 30 to 40 horses on the Station that are used entirely in cattle-moving operations.

Research on turkeys was also conducted at the Station. Studies with Bronze turkeys started in 1929 and involved approximately 1500 young turkeys and 350 breeding hens. Studies consisted of feeding, breeding and rearing experiments, and the original crosses and the early work lead to development of the Beltsville White breed.

Previous swine research was directed largely toward production of Wiltshire Sides for the European pork market. In 1930, pork from the U.S. Range Livestock Experiment Station was reported to be the best American Wiltshire Sides on the London market. The swine work is most famous for the development of the Montana No. 1 breed. This was produced by crossing the Danish Landrace and the Black Hampshire breed. Crosses were inbred and through selection, one of the first meat-type breeds was established. Federal funding for Station swine research was terminated in 1968 and, since that time, swine work was directed by staff members in the Animal and Range Sciences Department at Montana State University. Work involving the Montana No. 1 and the Yorkshire breeds was terminated in 1971 and a crossbred herd was established to supply animals for studies directed by Montana State University nutritionists. The swine research was moved from Fort Keogh to Bozeman in 1986 and the swine unit closed out.

BEEF CATTLE RESEARCH

The broad goal of the beef research program at this Station is to increase the efficiency of beef production from cattle maintained in a range environment. The work involves research studies in the areas of animal breeding, physiology of reproduction, animal nutrition and range pasture development, improvement and management. In addition, some studies on various diseases have also been conducted. It is believed that scientists at this Station were the first to investigate methods for control of brucellosis that were applicable to range and semi-arid conditions. Other studies have involved determining methods for control of eye cancer and the effects of vaginal and uterine prolapse on cow productivity. Funding for research is by the appropriation process through USDA-ARS. No appropriated funds are received from the State of Montana. Funds on this side of the ledger are from income funds from receipts for the sale of cattle.

CATTLE BREEDING

Beginning in 1930, the Station pioneered in the development of methods for evaluating performance in beef cattle. All beef performance testing programs now active in the United States and much of the remainder of the world trace to these pioneering activities. Perhaps the most important contribution of these experiments was the determination of heritability estimates for economically important traits in beef cattle. This gave knowledge of the comparative influences of heredity and environment in performance and has greatly improved selection techniques.

The first large-scale linebreeding studies in beef cattle in the United States were initiated at the Station. A number of lines of purebred Hereford cattle have been developed and have been or are being tested for production potential. These studies have resulted in the development of highly productive lines of cattle, Line 1 being the most famous. The objective of these experiments is to determine the improvement that can be made in a closed population of beef cattle starting from a superior genetic base. The oldest line (Line 1) has not had an introduction of either bulls or cows since 1934. Animals surplus to the research program are sold at an annual production sale, and animals from this line are now widely used in purebred and commercial beef herds throughout the Unites States. In 1980, Station scientists received a Superior Service Award from the USDA for development of this Line and the impact it has had on the Hereford breed.

One of the first findings in the line breeding study was that linebreeding is profitable only when practiced with cattle that exceed the breed average for most production traits. Despite the fact that the original lines in the studies were selected from presumed top herds, many did not respond to linebreeding and had to be discarded. However, the success of several lines, notably Lines 1, 12 and 14, has proved that a linebreeding program, coupled with strict selection for performance, is an economically feasible method of improvement for beef cattle.

Semen was collected from Line 1 bulls in 1955, 1965 and 1975 and used for breeding within a common group of females. This work was conducted to determine the permanent genetic progress or change established through selection. Results indicated that selection permanently improved all economically important traits, and the improvements actually observed agreed closely with the predicted values based on heritabilities of the various traits.

The long-term linebreeding research involving Line 1 was modified in 1977 to include selection for low birth weights. Calving difficulty problems are increasing nationwide and high birth weights have been identified as the main contributing factor. This work is designed to determine if selection of replacement sires with below average birth weight offers promise in alleviating this problem. Thus, Line 1 has been sublined with one-half of the Line being maintained with low birth weight as an added selection criterion. To date, this selection has resulted in a 5% decrease in birth weight of bull calves, but this was accompanied by lower weaning weights and gains on test.

Several of the lines have been crossed in a study to determine if hybrid vigor or heterosis would result. This work has shown that the linecross animals excelled the average production of the parents for all economically important traits studied. The greatest increases were realized from crossing of the highest producing lines. Additional work has indicated that continued crossing of lines within the breed can result in increased production. However, results show that topcrossing a linebred sire on unrelated females is the most practical method of realizing increased production.

Other work with inbred lines of cattle indicates that the maximum improvement in weaning weight or yearling weight, for example, can be obtained by selecting replacements for high weaning weights or yearling weights, respectively. Cattle have also been involved in a study to determine what effect selecting herd sires with low back fat thickness might have on subsequent fat and lean composition in their progeny. Results indicated sires with lower back fat thickness produced offspring with a higher proportion of lean in the carcass.

A selection study designated the Selection Criteria Study involves a Hereford herd of randomly selected males and females. The objective of this study is to determine the relationships among measures of growth, fertility and nutrient requirements in bulls, heifers and cows managed under range conditions in order to identify alternative selection criteria that can maximize total production by maintaining rapid growth rate accompanied by high fertility in both males and females.

A genetic environmental interaction study started in 1961 involved exchange of cattle between Miles City and Brooksville, Florida. Results showed both herds performed best at their place of origin. These results suggest that seedstock for a specific type environment should be obtained from a similar type environment if optimum production is to be realized. This work further indicated that animals transferred to a new location go through an adjustment or adaptation period and that selection within the new environment will result in adapted, high-producing animals.

Several crossbreeding studies have been conducted at this location. The early work, started in 1935, involved Hereford, Angus and Shorthorn breeds. Later studies starting in 1961 involved Hereford, Angus, Charolais and Brown Swiss breeds to evaluate the merit of two- and three-breed rotational crossing. A three-breed composite population was used for the preweaning and postweaning performance. Maximum production among three-breed crossing systems over the straightbred average was obtained by the three-breed rotation followed by the composite group and two-way rotation, in that order. A four-breed composite of the Angus, Hereford, Charolais and Brown Swiss breeds had a higher preweaning and postweaning growth rate than the crosses involving the beef breeds only.

Puberty information has indicated crossbred bulls and heifers are potentially fertile at younger ages than are straightbreds. Comparisons have also been made of feedlot performance of bulls and steers. Bulls had heavier weaning weights and continued to grow faster in the feedlot. Bulls required less time in the feedlot, were more efficient gainers, had a higher percentage of lean in the carcass, but produced lower grading carcasses than steers. Marketing and consumer acceptance problems must be overcome, however, before bull feeding can prove profitable.

A more recent crossbreeding study was designed to evaluate the crossbred female for performance as a brood cow under range conditions. First cross females from sire breeds representing medium cow size, medium level of milk production; medium cow size, higher level of milk production; larger cow size, medium level of milk production; and large cow size, higher level of milk production were evaluated. These females were mated to Shorthorn sires as yearlings and to Charolais sires as cows. Crossbred offspring were evaluated for growth performance in the feedlot and carcass characteristics. Results suggest that the forage available from ranges in semi-arid areas is not adequate to permit large, high milk-producing breeds to perform at an acceptable level.

A new selection-crossbreeding study was initiated in 1979 to determine rate of progress when selection is made within a multibreed composite population. Three breeds are involved in this study, Red Angus (RA), Polled Charolais (C) and Tarentaise (T). The breeds were selected to compliment each other in terms of total productivity and to determine rate of progress when selection is made in a multibreed population. In the formative stage, C and T sires were bred to RA dams by artificial insemination. In the next phase (Phase II), the CRA first cross males were mated to TRA females and the TRA males to the CRA females to produce offspring of the same genetic composition (25% C, 25% T, 50% RA) but produced from different mating systems. In Phase III, these 25% C, 25% T, 50% RA will be mated together. Semen will be collected from Phase III crossbred bulls to determine genetic change on future generations. Evaluation of Phase III females and their offspring will be made under different range management systems.

REPRODUCTION

The objective of research in reproductive physiology is to increase reproductive efficiency of range cattle. Areas of work are directed toward increasing the percent calf crop to optimum levels in conjunction with the other disciplines at the Station, increasing the pounds of calf produced per acre and per cow exposed to breeding. It has been found that the largest single reason that cows do not wean calves is because they fail to become pregnant during the breeding season. The second largest loss occurs because cows lose calves at or shortly after birth. These areas are receiving major emphasis in reproduction research studies.

Approximately 15% to 20% of the beef breeding herd is replaced yearly. Thus, replacement heifers make up about one in every seven females in the breeding herd. Assuring a high pregnancy rate in the replacement heifer is the objective of puberty research at the Station, and this work has shown that proper nutritional and genetic management of the heifer can increase conception rates by 20%. Simply feeding heifers in separate groups based on heavy or light weaning weights resulted in a 19% increase in pregnancy rate during the first breeding season with no increase in total feed costs. Station research has shown that feeding heifer calves monensin during the first winter following weaning hastens puberty. Additional work has shown heifers must be on a nutritional plane that will allow maximum skeletal growth so growth of the pelvic opening will not be reduced and result in increased calving problems. Recent studies have shown puberty and conception can be induced in young heifers by hormonal treatments but altering day length (photoperiod) had no effect. Implanting heifers with zeranol (Ralgro®) increased gain but pregnancy rates were reduced. Use of Ralgro® in young bull calves reduced testicle size, thus the use of this compound in potential breeding animals is not recommended. Recent work has shown that up to 22% of replacement heifers will show a nonpuberal behavioral heat early in development of their reproductive potential prior to puberty. This nonpuberal heat is not considered an abnormal condition since subsequent pregnancy rates following its occurrence are the same as in heifers in which it was not observed. Another study has shown that replacement heifers bred at their third heat had a 23% higher conception rate that heifers bred at their first or puberal heat. These studies clearly show that heifers should be managed so they are cycling before the beginning of the breeding season. These findings are important, not only in terms of increased calf crop, but also because early puberty means potential early conception and calving. Research in this area expands the flexibility producers have in selecting programs for managing replacement animals.

Failure of cows to rebreed or rebreeding late in the breeding season results in a 15-25% reduction in potential pounds of calf weaned per cow exposed to the bull. Station research has shown that the major cause of this reduction is a result of poor nutrition during one or both of two critical periods. The first critical period is during the last 3 months of pregnancy. Inadequate energy intake during this period in pregnant heifers can result in a 20% reduction in calf crop with little effect on calf birth weight and no benefit in reducing calf losses due to calving difficulty. The second critical period is during the time after calving until adequate grass is available on native range (usually from March through May). Unless adequate nutrition is supplied by proper supplementation or by providing pastures with early season introduced grasses, cows will lose weight and have lower calf crops.

Failure of females to breed at the appointed time, whether they be replacement heifers or mature cows, represents inadequate ovarian function. Research on ovarian function has provided detail on the nature of ovarian failures and how they are affected by such management factors as genetics and nutrition. These studies also provide means of controlling ovarian function to provide large numbers of ova (eggs) for embryo transfer programs.

Calf losses at birth result in a major reduction in the net calf crop. Data have shown 60% of these losses could be prevented by giving timely and proper assistance to dams experiencing difficulty during calving. In addition, the LARRL research has shown that proper, early obstetrical assistance will reduce the rebreeding problems often encountered in dams that experience calving difficulty. Other studies have shown that the feed level during gestation or exercise of the pregnant dam have little predictable effect on calving difficulty. Calf birth weight is the most important causative factor associated with calving difficulty. But, results of Station research indicate 70% of the identified variations in calving difficulty are either present or are established at conception and that ranking of birth weight differences exist prior to day 200 of gestation. This is why little can be done to alter calving difficulty by changing factors during gestation and emphasizes the importance of adequate heifer development and wise selection of sires for breeding to first calf heifers. Other Station studies indicate feeding pregnant dams in the evening resulted in 17% fewer calvings from midnight to 6 a.m. than when dams were fed at 8 a.m. Recent work has shown that precalving hormone changes in heifers that experience calving problems differ from those that calve without difficulty. This adds a new dimension to dystocia considerations and indicates that high birth weights and hormone abnormalities acting separately or together can cause calving difficulty. In another series of studies, we found that dams that experience rapid completion of calving (labor) had pregnancy rates 13% higher than dams in which labor was prolonged. These studies also found that calves experiencing rapid delivery gained 7 to 12% faster than calves experiencing prolonged labor. Brahman dams appear to have the ability to reduce the rate of calf growth in the uterus resulting in lower birth weights and less calving difficulty. Present research involves determining maternal effects on fetal growth. These studies are all directed toward discovering ways to reduce the estimated $600 million annual loss attributed to calving problems.

Suckling has a major delaying effect on the interval from calving to first postpartum estrus. The postpartum interval can be shortened by high levels of feeding, weaning the calf or by removal of the mammary gland. Additional data indicate suckling can alter the release of luteinizing hormone from the pituitary gland, the weaning effect can be mimicked by giving low dose injections of GnRH every 2 hours and these effects are quite different depending on whether the cow is fat or thin. Since degree of fatness or body composition is so important in reproduction as well as nutrition and genetics, extensive studies are underway to develop methods for determining body fat content in the live animal. Recent basic studies have attempted to determine how such effects as feed level, suckling and steroid hormone feedback control the release of pituitary hormones. The nervous system may be a part of this control through production of a class of compounds called endogenous opioid peptides (EOP). Our evidence is that EOP do have a role in the control of pituitary function in heifers and cows but that role is somewhat limited.

Station research has shown that conception rates following artificial insemination can be increased over 6% by massage of the reproductive tract (specifically the clitoris) following routine A.I. Benefits resulting include more pregnancies and less semen used because of fewer services per conception. Estimates indicate benefits could increase annual income over $200,000 in Montana and over $4 million nationally.

Effective methods for synchronization of estrus to obtain a high conception rate are definite possibilities. Recent Station results show a combination of a progesterone implant plus injected prostaglandin is the most promising.

Successful production of twins and triplets from beef cows has been accomplished at LARRL. This research was among the first to successfully combine synchronization of estrus and drug treatments for superovulation (increased production of ova or eggs). Calf crops of up to 119% were produced following a single breeding compared to 70% in untreated cows. This work has the potential of increasing the calf crop without an increase in the number of brood cows in the herd. Station research has shown that if twin and triplet calves receive colostrum and are weaned at birth they can be successfully artificially reared on cold milk or cold milk replacer plus grain and hay. This practice results in the added bonus that the dams will return to breeding condition and become pregnant very early following calving. Recent work is designed to develop methods to produce twins through use of embryo transfer. We have recently produced unrelated twins by transferring a frozen-thawed Brahman embryo into a crossbred cow that had been bred 8-days earlier to a Hereford bull. The twin sets consisted of a Brahman sired and a Hereford sired calf which were normal in all respects. Frozen embryos are also being used to produce identical twin offspring.

Superovulation is a critical part of any successful embryo transfer program, but results are often unpredictable. Research is underway to determine why and investigate mechanisms controlling growth of ovarian follicles and determine their response to hormonal stimulation. Oocytes are being obtained directly from follicles, fertilized in the laboratory (in vitro) and their subsequent growth determined. The next step will be to obtain viable pregnancies from these "cultured" embryos. Additional follicle work consists of determining hormone production within individual follicles, what controls ovulation rate in the cow and what determines which ovarian follicle is destined for growth and ovulation. These basic studies are designed to determine why approximately 20% of the nation's cow herd does not become pregnant during a normal breeding season.

Abortion losses are a significant problem to cattle producers. These abortions are caused by a variety of management variables and diseases, but the majority of causes are unknown. Ponderosa pine needles are known to cause abortions in the 17 western states, and we know little about why cows eat them, how or why the needles cause abortions or how to prevent these effects. We are conducting research to find out how pine needles cause abortions and are trying to devise treatments or methods to prevent these abortions. We have found that needles collected in winter or summer and from Oregon and Montana all caused abortions. Cows fed pine needles earlier in pregnancy (3-4 months) do not abort but as pregnancy progresses the abortion response increases until essentially all cows abort in the last few weeks of pregnancy. Level of feeding (1.5 to 6 pounds) and length of feeding (1 to 21 days) both cause an affect response. Feeding for only 1 or 3 days will cause some abortions, but longer feeding periods (10 to 14 days) are required to get all cows to abort. Vitamin A injections did not prevent abortions. Erratic and dramatic changes in hormone secretion patterns were observed but the corpus luteum does not appear to be the site of the action effect.

RANGE AND RANGE NUTRITION RESEARCH

Research in range improvement and management was initiated at Fort Keogh LARRL by the U. S. Forest Service in 1932. Early studies were designed to determine optimum stocking rates for cattle and sheep on Northern Great Plains rangelands. Recommendations were developed for proper use by both kinds of animals on different range sites and during different seasons. Also, the long- and short-term changes and effects of drought on vegetation and livestock performance were determined for these rangelands. The 30 acres per cow average stocking rate figure established in this work is used extensively by both ranchers and Federal agencies to establish proper stocking rates. Use of this stocking rate plus forage utilization standards of 50% use took the Plains out of an era of exploitation into one of grazing management. Use of these standards reduced soil loss, increased plant growth and increased production of both domestic livestock and wild animals. Value to the livestock industry and Montana agriculture on a sustained yield basis is conservatively estimated at over $1 billion. The research has also provided a foundation for making adjustments to drought such as those experienced in the late 1970's and mid 1980's. These stocking rate guides are now receiving additional research attention because of the increase in cow size from improved breeding and crossbreeding programs.

Other studies were made to determine the most effective methods of increasing forage production. These early studies included adaptability studies which tested more than 100 different plant species under various range conditions. Crested wheatgrass was found to be an outstanding species for seeding many range sites. Later research at LARRL, other Northern Great Plains institutions and in Canada has been instrumental in developing and promoting use of crested wheatgrass and Russian wildrye as introduced forage species and defining species tolerant of drought. These species have been planted on several million acres of Northern Great Plains rangelands. Studies at LARRL have shown a 17% increase in pounds of calf produced per cow in herds grazing introduced forage species during the critical postpartum rebreeding period.

Beginning in 1936, water spreading systems were developed by building diversion dams and contour dikes. These studies were among the first in the Nation to demonstrate that water normally lost to run-off could be used effectively to increase growth of native and introduced grasses. Over the years, studies have also been made of other methods of range improvements including furrowing, range pitting, and application of various kinds and amounts of mineral fertilizers. Recently a Range Improvement Machine (RIM) was developed and tested by LARRL and MAES. This machine and new varieties of plants show promise for substantially increasing plant and animal productivity from Northern Great Plains rangelands.

Cooperative research between scientists at LARRL and Logan, Utah, on new hybrid grass species and use of improved forage plants hold promise of increasing rangeland productivity as much or more than that experienced in the past. About 20 years of research by plant geneticists, plant breeders and range scientists have gone into plant development work. The promise of benefits to individuals and agriculture in Montana are enormous. Plants are being tested for growing in saline soils and restoring rangelands subject to saline seep. Hybrids are being developed and tested for increasing livestock production and growth. Other accessions are being evaluated for increasing productivity through more efficient use of limited water resources. Current range studies are designed to evaluate critically the range forage supply and determine methods of effectively increasing the quantity and quality of forages. Work is in progress on evaluating genetically superior grass hybrid selections for adaptability, viability and forage suitability. A number of forage species are being analyzed for their ability to contribute high quality grazeable forage at such critical times as very early spring, late fall and winter. Evaluations include seedling establishment, yield, post-harvest regrowth and vigor in relation to morphological and physiological attributes of both native and introduced plant species. Efforts are being directed toward determining the most effective management practices consistent with optimum response of individual species.

Work is also in progress to control or modify undesirable plant communities on potentially productive range sites through burning, mechanical and herbicide treatments. The objective is to increase forage productivity by introducing new species, increasing the growth and yield of established desirable plants, or by decreasing competition from undesirable species. A better understanding of how plants respond to environmental conditions and varied management treatments is basic to this research.

Nutrition studies were initiated at LARRL in 1971 and have shown the importance of proper winter supplementation as measured by improved conception rates, calf survival and cow and calf growth. Studies on protein, energy, vitamin A and phosphorous supplementation have been of importance to producers of yearling and cow-calf producers. More recent research has shown that a 10% savings in cost of winter supplement can be realized by gearing supplementation to the amount and kind of range forage available. This type of supplemental feeding can reduce the amount of feed required and also increase the efficiency of use of available forages.

Failure of the cow to conceive results in a substantial economic loss to the nation's beef producers and is a major factor reducing the production efficiency of beef herds. Pre- and postpartum nutritional status of the cow have a pronounced effect on body condition and weight changes, milk production and interval to first estrus and conception rate. One method of providing potentially deficient nutrients to cows during the critical postpartum and breeding periods is through supplement programs. However, these programs can be expensive. An effective alternative to supplement programs may be the development of pastures seeded to improved native or introduced species. Data are currently being collected to evaluate various combinations of seeded pastures and native range for the postpartum period (up to 1 week after parturition) and for the breeding season (45 days).

Range nutrition studies throughout the Northern Great Plains have shown that optimum animal performance is entirely dependent on adequate forage. Cooperative studies between LARRL and the Northern Great Plains Soil and Water Research Center at Sidney, Montana have shown important methods of increasing forage production. Contour furrowing of panspot areas increased forage production from only 350 pounds per acre to 1100 pounds per acre. Nitrogen fertilization of native range areas resulted in increased beef production roughly equivalent to 1 pound of beef for each 1 pound of available nitrogen added per acre. These two procedures could potentially result in an additional $15 million added income for Montana producers alone.

Winters in the Northern Great Plains can be long and cold. Loss of body weight by range cows has often been associated with harsh winter weather. Grazing trials here at LARRL have shown that reductions in the air temperature from 0 to -40 C resulted in a 50% reduction of daily grazing time. Forage intake was also significantly reduced at cold temperatures. Maintenance requirements of the cow are increased due to cold. Therefore, with low forage intake, a large negative energy balance in the cow would occur. Winter management strategies should therefore be developed which not only include increased energy requirements for cold but also account for low levels of forage intake. In another study, performance and behavior of cows of various body size and body condition were studied during the fall-winter grazing period. Grazing behavior was affected by cow size but not body condition.

Both body condition and body size affected forage intake and performance of the cow. Time spent grazing and forage intake were lower at colder than warmer temperatures for all cows.

Alfalfa cubes or a cottonseed meal-barley pellet was fed during the fall-winter periods to cows on native range to evaluate effects on animal performance. Supplements were fed to provide approximately 50% of the crude protein requirement. Supplementing cows with alfalfa cubes resulted in improved performance compared with cows given cottonseed meal-barley as a supplement to range forage and those consuming range forage with no supplemental feeds provided. Performance and behavior of large and small cows in either high body condition (fat) or low body condition (thin) grazing winter range were evaluated for effects of body condition on winter metabolism and performance. Forage intake was greater for large or thin cows than for small or fat cows, respectively. However, forage intake was lowest for large and fat cows when expressed on kg/100 kg of body weight basis. Forage digestibility was similar for all cows. Differences in time spent grazing were small between treatment groups. All of these factors are critical to maintaining range cattle in the Northern Great Plains and are of significant economic importance to the livestock industry.

An automated range-animal data acquisition system (ARADS) has been developed to collect individual animal data without human intervention. Records include date, time, identification, live-weight, water consumption, and weather variables. The system is presently being used to moniter free-ranging yearling steers and mature cows. ARADS is composed of seven portable scale units, a weather station, and a central computer all linked together through a radio communication network. The system is expandable to include additional data stations and parameters.